VOLUME IX #2 DECEMBER 1993 PRICE $6

FOR THE DESIGN, CONSTRUCTION AND ENJOYMENT OF UNUSUAL SOUND SOURCES

EXPERIMENTAL MUSICAL INSTRUMENTS

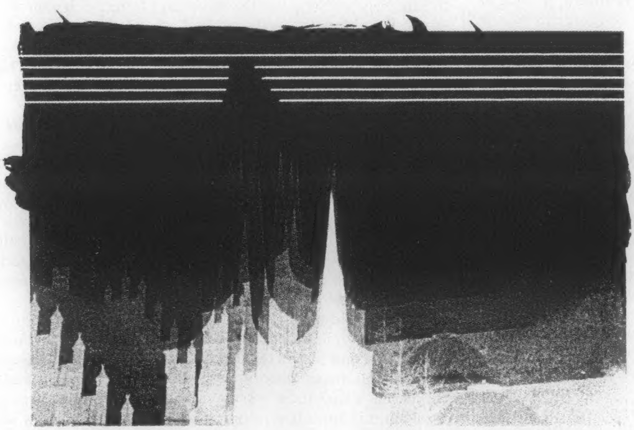
IN THIS ISSUE

BAMBOO & BELL METAL

To make a saxophone, with its particular bore shape, specialized mouthpiece, and elaborate keywork, is no small project. It is unlikely that anyone but trained specialists, working in a well-equipped factory setting, would undertake it. But it is possible to produce a slightly more humble instrument, made with simpler procedures and materials, yet having much of the warmth and sinuous flexibility of professionally manufactured instruments. And so ... in this issue of EMI we have an article on the late great Jamaican bamboo saxophone maker and player, Sugarbelly Walker. Following are additional notes from Brian Wittman in Hawaii, who produces the excellent bamboo saxophone called *Maui Xaphoon*.

Also in this issue you'll find a report one of the glorious instruments made in the early days of this century by J.C. Deagan and company, the Organ Chimes. A dozen, maybe two, of the chime sets survive in playable condition; read about them here. We also have a set of highly thought-provoking observations on relationships between instrumental timbre and musical scales from author Bill Sethares, leading to a practical theory on the creation of scales most suitable for specific timbres, and vice verse.

And there is much more in this issue, but I'm running out of space to describe it here. Open up, and read.



Artwork this page: "Roskilde morning tuned" by William Louis Soerensen, Denmark, 1991.

FOUND A USED DISC at Amoeba [record store] in Berkeley last night. It's on the Arhoolie label (release number HF30 01) and features a man playing "Da Setz'i' mein grün's Hütl auf" on a brick xylophone!! The lp is called *Austrian Folk Music Vol. I – The Eastern Provinces*. It even has a *picture* of Karl Scherrer and his brick xylophone. In case you didn't know about this one, I wanted to let you know. I don't know if it's still in print (this copy is quite trashed). The record also includes cymbaloms, glockenspiels, a one man band, and carousel-type things. Very nice disc indeed. Something the readers of EMI should know about.

Gino Robair

From the editor: A phone call to Arhoolie reveals that this old treasure is now out of print and unavailable. At right is a reproduction of the brick xylophone photograph – thanks to Gino for sending the jacket to copy the photo from.

I SAW IN PRINT, so it must be true: "Debbie Suran, master instrument builder" [in EMI's last issue, Vol. IX #1]. I do want to say that I only build and sell hammered dulcimers these days, and that the ones I build have 26 courses (13 treble and 13 bass), not "23 strings." Thanks for the mention!

Debbie Suran

In the Tradition, PO Box 223, Deer Isle, ME 04627

The following is gathered from several recent letters from instrument builder, microtonal theorist and irrepressible correspondent Ivor Darreg.

The Transister's Lament for her Long-Lost Transbrother

I HAVE TO ANSWER IMMEDIATELY on receiving your latest issue of EMI because I have a sort of moral obligation to you: those letters about other instruments not the thereminvox, also played without touching them. [The reference is to letters appearing in EMI Vol. IX #1 commenting on the article on theremin by Ivor Darreg & Bart Hopkin in Vol. VIII #3]. As by photoelectric cells and light-beams, or as by inertia-operated switches inside "drumsticks" (the Air-Drums, and I had a chance about 5 years ago to play them when my turn came at a big demo in a synthesizer store several miles from here on the hill). Others played by shining a flashlight beam on something at a fair distance. Interrupting a light beam or beams. Singing a note into a microphone near you which the apparatus re-tunes if the note is not in tune with the scale of that instrument, and not amplifying your sung tone at all, but causing the *re*tuned pitch in some other non-vocal *timbre* to be heard. (A number of those things were patented. Never heard any demos.)

Video-cameras that "see" the performer's actions? Well sure. But all the above are very very much LATER than the Thereminvox we were writing about! Practically NOTHING about such non-touched instruments in our source-books and source-magazine-articles and in my correspondence with over a hundred persons during fifty-odd years, some of which years were *very* odd.

Surely playing without touching is not the novelty and unique phenomenon it was back in 1919 or in 1928 or in 1946 when I built a theremin. But we were writing the HISTORY with emphasis on how the space-controlled beat-oscillator instrument BEGAN and reached public performance, not about the last decade's novel new inventions.

For that matter, there are now elevator controls where you bring your finger or hand very near without PRESSING on the control-plate. These do what pushbuttons have done till very recently.

I have a burglar alarm that will shriek if somebody walks around in the front part of this house. Infrared sensor that responds to reflected infrared light. But that didn't exist at the times we wrote about.

* * * * * * * * *

Several years ago I was able to get some 78 rpm records of the Hammond Novachord [an electronic keyboard instrument] – three short records, probably vintage 1940 – but never to play them, since my turntable that could play 78's was smashed in moving to San Diego in 1985. Just the other day I found such a turntable in excellent like-new condition, so I copied these disks onto a cassette and will make a Comparison Demo with the modern and much better keyboards that have been lent me here ... extremely brittle shellac records just impatient and anxious to get broken – I don't know *how* they survived the moving.

The Novachord looked like a spinet piano but had only 6 octaves. It had something like 155 vacuum tubes in it, most of these of a type that has not been made for decades. It had a peculiar nagging whining sound, something like an ensemble of 25 hungry Siamese cats. Introduced in 1939, I guess it was invented to be the successor to the piano, but World War II killed it off and soon after the end of the War, much better electronic keyboards came on the market. Also, the staggering colossal success of the Hammond Gear-Wheel Organ eclipsed it – that kind of phenomenon couldn't be repeated.

I had lots of chances to hear a Novachord back in the old days and a few chances to play one. But the present generations haven't. So now after a terribly long wait I can preserve this bit of electronic music history and make a few copied cassettes comparing it with today's keyboards. Nobody would want one now, but it is important to preserve that sound and show what was good about it and what was very bad about it. The piano-makers and other conservative/reactionary music interests

fought extremely hard against it and of course won. But I can't shed any tears because the giant soulless corporation that made it was hardly a force for progress in music nor for experimenters like us! All they cared about was dollar-signs. The only music they wanted was BANK notes. Finally they died out. Sic transit glorie mundi.

* * * * * * *

People have been trying to scare me silly — for quite some time in fact: Shouldn't I be afraid, they ask, that everything I have done in my 76 years will be lost? Well of course! Since I was a little boy, I have seen this happen to many other persons. They took ill, they moved, some disaster, they died. And everything was junked, wrecked, burnt up, gone forever.

There isn't one single person in California these days for whom anything can be permanent. In our present subject, EXPERIMENTAL MUSICAL INSTRUMENTS, this is much worse than for average projects of average people. So I have been frantically grinding out copy-tapes and Xeroxes and sending them to faraway places as much as I can afford. Recently, understanding this, new people have come to me and helped out in this effort and they have taken many photos and just lately, videos.

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SUBMISSIONS: Experimental Musical Instruments welcomes submissions of articles relating to new or unusual musical instruments. A query letter or phone call is suggested before sending articles.

I've done my part by spreading the news as much as I could, of what my colleagues have been doing, for instance, through twenty years of *Xenharonic Bulletins* (all these bulletins are recopied and still available!) [Xenharmonic Bulletin is Ivor Darreg's newsletter on microtonality and related topics, available from his address below].

30 years ago, May/June 1963, I was asked to improvise music for a stage play put on in Hollywood. I later transcribed all the tape into notes and edited them, so in 1967 produced a final-draft score. Recently got this out of the mothballs and had Xeroxes made, so *that* is available. The 30-year-old tape can still make copies — mono of course. If I have time I will play some of it over on newer instruments. But that's a big IF. What can I do NOW? I am enclosing a cassette-copy of most of **IN LIMBO**, a suite of ten pieces that was done for the play. This is relevant to your efforts because I *built* all the instruments, as well as playing them and composing — improvising on the spur of the moment — for them. Experimental compositions for experimental instruments. More urgent now because the Amplifying Clavichord of 1940 and the Elastic-Tuning Organ of 1962 [instruments built by Ivor Darreg] were *both* destroyed in moving and storage. I still have the Electric Keyboard Drum and the Theremin, which last has just been repaired.

The Amplifying Clavichord was not designed for mass-production, but as a flexible instrument that could do what the traditional clavichord could never do, and even I could not fake it on synthesizers well enough. The Elastic-Tuning Organ deliberately and intentionally was built with slightly different parts and therefore different individual timbres for EVERY NOTE on the instrument, not confined to the rigid uniformity of electronic organs produced in huge quantities by impersonal factories. To market thousand of identical organs, UNIFORMITY is necessary; I did not have that constraint. Most of its notes could re-tune each other WHILE A CHORD WAS SOUNDING. That is utterly out of the question for commercial manufacture! So I have been scolded and insulted and severely condemned for having built these instruments.

The sound cannot be described in words, so I must make tapes even though the Perfectionists complain about copying a 30-year old tape. Must I go down in permanent silence? Or do I ever get heard?

Ivor Darreg
3612 Polk Ave., San Diego, CA 92104

NOTES FROM HERE AND THERE

THE RESPECTED instrument maker/researcher/explorer Ben Hume will conduct a two-day seminar and demonstration, followed by a one-day hands-on workshop, in San Francisco this January. In his studies Ben has emphasized the evolution of musical instruments as a key to understanding which properties as are enduring, practical and musically meaningful. The dates are Saturday and Sunday January 8 and 9, 10am to 5pm for the seminar/demo; Saturday January 15 10am to 5pm for the workshop; al at 666 Illinois St. (between 18th St. and Mariposa), San Francisco CA 94107. The cost is $160 for the 8th and 9th; $100 for the 15th (scholarships or work-study available — call for information). Space is limited. For reservations or information call (415) 431-1444.

SCHEDULE FOR THE SEMINAR & WORKSHOP:

Saturday Jan 8: Seminar — Winds & Drums.
Instruments covered: endblown, notched, transverse, fipple & vessel flutes; reed instruments (single beaters, simple double reeds and bagpipes); drums (cylinders, goblets, cones, barrels & double heads). Principles covered: Modes of vibration in air columns & chambers, harmonic series, the mysticism of craft, wave distances and hydraulics ("it's just that people refuse to treat air as a fluid"), tap tuning.

Sunday Jan 9: Seminar — Strings.
Instruments covered: Central Asian long necked lutes ("why they explain everything"), early fiddles, harps. Principles covered: necks, bodies, soundboards (skin & wood), resonance (clearing a form), tap tuning (why it evolved and why some makers don't believe in it), choosing & scaling strings, making your own gut strings, sources for materials & tools, improvised music as a mystic discipline.

Saturday Jan 15: Workshop — Making a bamboo Jew's harp.
The making of bamboo Jew's harps will demonstrate principles that underlie the construction of nearly all musical instruments. Materials & tools provided.

FOR MANY YEARS Robin Goodfellow's stippled drawings have been a regular feature in EMI, and indeed one of the essential elements in EMI's graphic per-

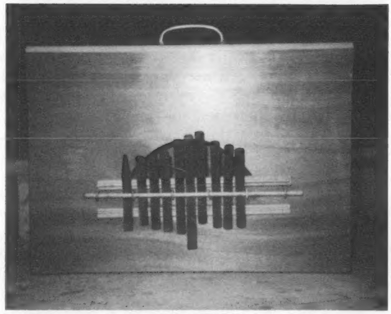
sonality. Now Robin has gathered 23 of her drawings of musical instruments from around the world into a booklet entitled *A House of Instruments*. Many of the drawings first appeared in EMI; most of them depict instruments from her own large and unique instrument collection. *A House of Instruments* is available for $5 (p&h included) from Mandala Fluteworks, 1655 Vista, Oakland, CA 94602.

A NOTE TO EMI CONTRIBUTORS: We've expanded our computer text file conversion capabilities here in EMI's office. In addition to DOS ASCII files, DCA files and the now-outdated Samna, we can now handle Microsoft Word (including various releases of Word for Windows, Word for DOS, and Word for Mac), WordPerfect, and Rich Text Format (RTF). We're still not dependably able to translate Mac text formats aside from the above-mentioned Word for Mac. We can handle both 51/4" and 31/2" disks. When you submit articles, always include a print-out of your submission along with the disk. If you can't submit articles on disk in one of these formats, please send the best quality printed or typed version you can; this will help if we decide to input your text by optical character recognition.

THE PHOTOGRAPHS AND DIAGRAM ON THIS PAGE are from Andy Cox, of Limestone College in Gaffney, South Carolina. He writes –

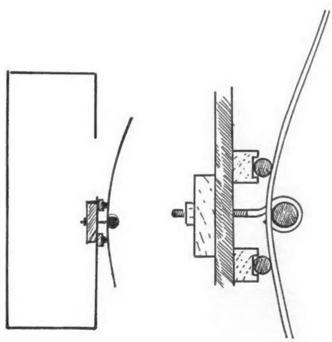
After reading your last issue of EMI [containing an article on marimbulas], I thought you'd be interested in our "Down South" attempts. We do not know what we are doing, and if we did, we probably would not even try. Enclosed are a few (very few) examples of instruments made here and performed by faculty at various colleges/universities.

For the marimbula, we use eyebolts, 3/8" steel rod on conduit pipe (1/2") [see the diagram], and have determined that the bridges should be kept shorter than models shown.



Photos this page: Lamellaphones made by Andy Cox & students at Limestone College. Top: Marimbula. 18" x 25" x 8". Lower photo: Kalimbas (about 20% of Andy's collection) – "I've, well ... have I ... been carried away?"

Below: Cut-away side view of the key mounting system Andy has been using on marimbulas, described in his letter above. The eyebolt passes between the keys, as can be seen in the top photo above.



The 13 Tone Ensemble

by Buzz Kimball

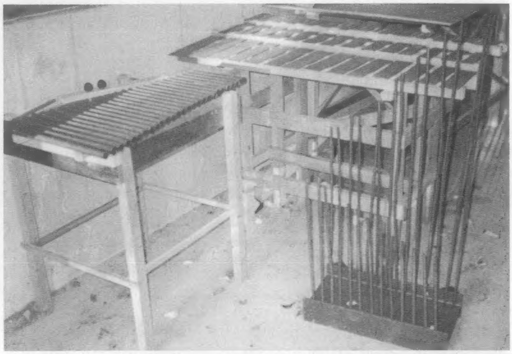
About 1981 I visited Ivor Darreg in Los Angeles and was introduced to the 13 tone scale through a wonderful sounding metallophone he had made using scrap aluminum bars which were shaped like a wedge. After I returned to New Hampshire I discovered 70-odd feet of 3/4" copper water conduit and it was adequate to make a tubulon in 13 tone equal scale.

The 13 scale has been considered to be as far different from the everyday 12-tone-equal scale as can be. Indeed, it is somewhat inharmonic, not having any ordinary chords or equivalent progressions as would be found in 12. But, what the scale lacks in harmonicity is more that compensated in its melodic aspects.

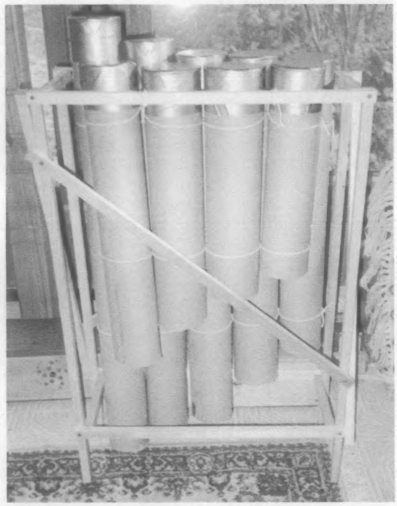
Many years later the tube instrument was followed by a bar instrument. And several years later after much procrastination, discouragement, and otherwise unwanted emotions I welded up the rod instrument to produce a full-fledged ensemble dedicated to the 13 tone scale.

The somewhat austere tonal qualities of metal seem to be perfect for the resources of the 13 tone scale. The notes have a certain definement but do not overpower each other. A synthesizer tuned to 13 equal and played with an organ tone is horrid; it makes the dentist's drill seem tame in comparison.

The tube, bar and rod instruments seem to be the most minimal and easy to construct metallic implements. An instrument based on tetrahedrons had suggested itself to me, but an experiment proved it nearly impossible to produce. Perhaps my metal working skills will improve someday.



ABOVE: Instruments of Buzz Kimball's 13-tone ensemble.



RIGHT: Just intonation cardboard bongos.

Just Intonation Cardboard Bongos

also by Buzz Kimball

A need occurred for some percussion instruments and I had happily explored several plastic containers. Quickly, I wanted something a bit more sophisticated. Balloon drums didn't seem to last long. So I was stymied when I investigated the possibility of buying an assortment of traditional world music drums and fabricating a drum kit that way. It would have been a bargain in comparison to a typical drum set; however, it still seemed prohibitive.

One day I was unearthing a mailing tube which was taped at one end, and a questioning tap sounded R-E-L-I-E-F. An adequate but not earthshaking sound in my price range.

A little scrounging turned up 3 1/2" diameter cardboard tubing which produced various tubes from 30" to 12". Merely taping on cardboard tops provides a membrane. The volume is nothing like cowhide, but then neither is the tension. Microphone amplification does produce a big sounding instrument.

"SUGAR BELLY" WALKER AND THE BAMBOO SAXOPHONE

by Bart Hopkin

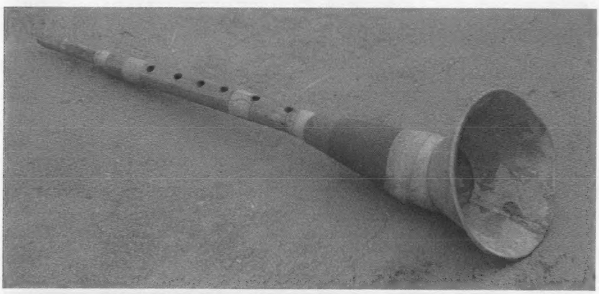
This is the second in a series of articles on Jamaican instrument makers appearing in **Experimental Musical Instruments**. *The first, on drum and rumba box maker Rupert Lewis, appeared in EMI's last issue (Sept. '93). A third, on a contemporary Jamaican idiochord zither known as* bamboolin *and a traditional one called* benta, *will appear in the coming March 1994 issue.*

Drawing by Robin Goodfellow

A few years ago one of the beloved figures of early Jamaican popular music passed away, and as so often seems to happen with once-popular musicians, he died in poverty. William Walker, known to all as Sugar Belly, developed on his own the instrument he called the bamboo saxophone, and played it with facility, style, passion and joy. At the height of his popularity in the late 1950s Sugar Belly was one of the important figures in the Jamaican music scene, turning his homemade saxophone into a natural vehicle for a distinctively Caribbean musical style.

THE MAN

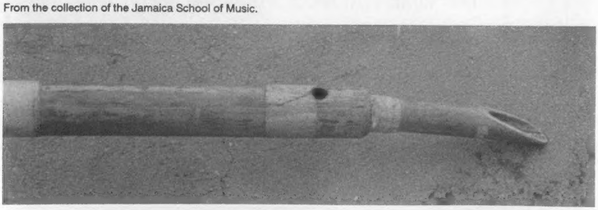
Sugar Belly was raised in Kingston. His economic background was lower class, and he was not well educated. In music he was entirely self-taught. It doesn't appear that he ever had any tutoring on a conventional saxophone. Just where he got the idea to create a bamboo saxophone is a bit of a mystery, since there is no traditional bamboo reed instrument in Jamaica, and no one that I have spoken to can recall seeing any other locally-made saxophone-like instrument in the island. Sugar Belly's instrument seems to have been entirely his own in conception and design. In its construction the instrument might seem simple and crude, but you know the tree by its fruit: from it Sugar Belly managed to bring the most fluid, warm, agile, and unquestionably sax-like music you could wish for.



Above: Bamboo saxophone by Sugar Belly Walker

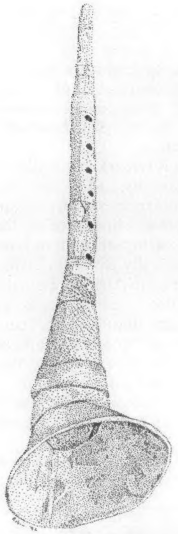
Below: Detail showing the cut-away of the mouthpiece, and the single tonehole on the back of the pipe.

From the collection of the Jamaica School of Music.



In the early days Sugar Belly played in talent exhibitions at Victoria Park in downtown Kingston, where years before Marcus Garvey had addressed the crowds. With increasing recognition he moved on to night clubs, such as the popular Glass Bucket located uptown at Halfway Tree. The leading popular music style in Jamaica at that time was *mento*. Mento evolved originally as a local extension of traditional quadrille dance music. In its mood it is closer to the easy good-times feel of the old Trinidadian calypso than it is to the more angular ska and reggae styles that were to develop later in Jamaica. Mento music is good natured, humorous, lively and danceable. Sugar Belly's band originally used a typical mento instrumentation of banjo, guitar and shakers, with the big bass kalimba known in Jamaica as a rumba box providing the bottom. Later he incorporated electric guitar and bass.

Through the 1960s mento gradually faded in popularity. Sugar Belly brought popular songs from a broader range of local and international styles into his repertoire; still, as time passed, he and his band were heard from less and less.



He later moved to the parish of St. Ann on the island's north coast, and it was there that he died circa 1990 following a long illness.

THE INSTRUMENT

Although he never approached instrument making in a commercial way, Sugar Belly did make a fair number of bamboo saxophones over the years, keeping some to play himself and selling others.

The main segment of his bamboo saxophone (see the photos) is a straight section of bamboo, an inch or so in diameter and something over a foot long. Into this at one end is inserted a mouthpiece of a few inches long, made from a smaller piece of bamboo sized so as to fit snugly into the main segment. Where a commercial sax has cork to ensure a leakless fit between the mouthpiece and the main tube, Sugar Belly put several rounds of masking tape to provide an adequate gasket.

The reed end of the mouthpiece terminates in a simple angle cut. Although it is hard to see it in the photographs, and I neglected to verify this when I had the instrument in hand, I suspect that the angle cut probably is not straight, but has a slight convex curvature. This provides what reed players call the "lay" of the mouthpiece, allowing for the required gap at the tip where the straight reed rises slightly from the gently curved mouthpiece surface. In lieu of a metal ligature, Sugar Belly took the time-honored approach of tying his reed to the mouthpiece with a piece of cord.

Originally, and for many years, Sugar Belly carved his reeds from bamboo. He turned to store-bought reeds only when his bamboo supply (which he found in the Hope River valley, not far from Kingston) gave way to coffee plantations and other forms of development. In Sugar Belly's hands, the instrument doesn't seem to have sounded very different with one sort of reed or the other.

At the other end of the main bamboo tube, Sugar Belly placed a conical commercial thread spool made of heavy cardboard. Once again, masking tape serves as a gasket to ensure a snug fit and a leakless joint. The conical spool in turn leads to a wider-angled funnel of tin. Sugar Belly had this one metal part fabricated for him by a tinsmith.

There are six fingerholes on the front of the instrument and one on the back, made by burning. Sugar Belly's own playing was primarily diatonic and in major keys, but through cross fingerings and half-holing he was able to include a bit of chromaticism here and there. The instrument lends itself to notes bent broadly through embouchure control, and Sugar Belly was a master of this as well. And he was also able to make excursions into a clear and dependable upper register.

One of Sugar Belly's saxophones can be seen in the instruments collection of the Jamaica School of Music at the Cultural Training Centre, 1 Arthur Wint Drive, Kingston 5, Jamaica. But no one seems to have followed him in making or playing a Jamaican bamboo saxophone. We are left with a few scratchy recordings, and the knowledge that it can be done.

This article would not have been possible were it not for assistance from Marjorie Whylie, who provided most of the information. Ms. Whylie knew Sugar Belly and his music when he was still around and kicking it. Beyond that, Marjorie's encyclopedic knowledge of Jamaican traditional and early popular music, always tempered with generous doses of insight, humanity, and humor, constitutes one of Jamaica's national treasures. And beyond that, she is a natural and inspired teacher. Thanks, Marjorie.

Thanks also to Derrick Johnson of the Jamaica School of Music, for opening the collection to me, providing additional information and assisting with photography.

Notes from Brian Wittman, Bamboo Saxophone Maker in Hawaii

ON SUGAR BELLY

I still remember the day Bart Hopkin sent me the tape of Sugar Belly, which went directly from the P.O. box to the car stereo as I rushed to pick up my kids from school. We all loved him immediately like a lost uncle. And all at once I felt sane and justified, for here was another man from earth who had build his life on the bamboo sax.

I have made over 15,000 such instruments in the past 20 years, all because of a single instrument I made on the whim of a child.

The young lad lived with his mother in a tent in the woods, and heard me playing the sax (the expensive metal variety). He approached respectfully and then boldly asked if perhaps I had a little one he could play. Why not? I fiddled around and whittled a small end-blown block flute out of bamboo. Its tone was wheezy and small, and satisfied neither of us. I had a small grinding wheel I was using to shape some wooden boat cleats, and in sudden inspiration I applied the flute to the wheel and ground off the whole corner of the mouthpiece at an angle, re-shaping it to take a sax reed. With a bit of string holding the reed, I blew a test note ... it screamed!

The child was delighted and couldn't wait to have it, so I passed it on, but immediately made myself another, this time a bit longer, and I made the mouthpiece first so I could hear the pitch as I located the finger holes. Somehow by chance I ended up with a serviceable scale in "E", and I couldn't put it down. I even played it one-handed as I drove into town, not noticing the speedometer was reading 80 until I heard the sirens.

Finally I arrived at the rehearsal studio where I was due, only to find a major hero, Mr. Airto Morierra (the Brazilian percussionist) just happened to be there jamming with my delighted band members. I jumped in on my new axe, and found that its strong warm tone could be as full as a sax, and amplified very well in an electric band setting. Airto was fascinated. so I offered this #2 instrument as a token of my respect for his music.

So I made a 3rd and played it on gigs. People would come up and ask about it ... Where did you get it? ... You made it? Can you make me one? ... What do you mean you don't have time – Here's my money! So I ended up in business. A name developed from "bamboozaphone" to "bamboozafoon" to "bamboo zafoon" to just "zafoon", also spelled "xaphoon". I eventually moved closer to the bamboo forests, and even took

out a patent in several countries. And as I answered my mail and filled the orders, the years went by. My children were born into a house built of bamboo saxophones, and heard them from the womb onward.

"Is that you on the tape, Dad?" No, that is the famous Sugar Belly, that I only now heard of just last week.

It is sad that we will never meet in this world. Yet I feel very thankful to know of Sugar Belly and to hear his music. We have touched the same whimsical source of magic from different worlds. Accidently walked in the same moccasins.

THE XAPHOON

The instrument I have made commercially all these years is not much different than the first experimental models. I did construct several larger instruments, some with conical extensions (usually cow horn), but rather than complicate the design with a number of pieces, I have elected to maintain the "one stick" concept with the mouthpiece carved directly on the end of the instrument body. Fortunately the bamboo naturally lends itself to this type of construction if it is carefully chosen in the forest for the correct length and diameter.

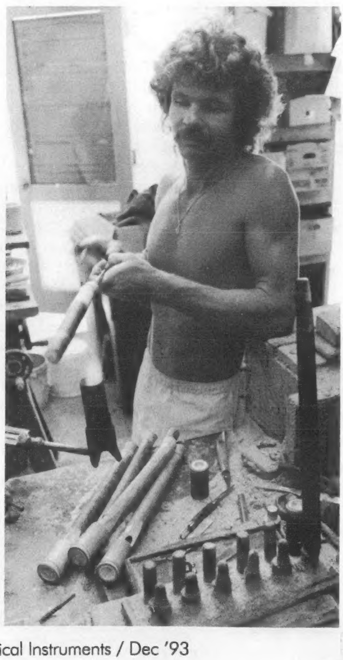
After some experimentation, I eventually found a hole placement and fingering system that will allow two complete chromatic octaves, though the instrument remains primarily diatonic. For example, it would be simple enough to play a C# note on a "C" instrument, or sketch through a riff in that key while following the chord changes, but it would not make much sense to transpose the entire tune to C#. There would be just too many cross-fingerings and lip adjustments.

I have generally restricted my output to "C" instruments, mostly to avoid confusing beginners with too many choices. I will gladly make instruments of any key, but only if the customer is still interested after having attained some skill on the "C". The "C" plays best in the keys of D,F, G, Gm, Dm, Am, etc.

The tone of my instruments is remarkably similar to what I hear on the tapes of Sugarbelly, and my personal style of playing has some resemblance as well, perhaps because of the inherent qualities and limitations of the instrument. However some of my customers have surprised me by adopting radically different styles, from Baroque to Peruvian to Irish to African. I greatly appreciate the occasional tapes I receive from my customers. One can well imagine that the actual construction of 15,000 of anything can become tedious, so it has become the satisfaction of customers that drives me (as well as the opportunity to feed my family). It is truly rewarding to receive orders from distant places and it does get easier to make them now than I know how.

I can only wonder though, if perhaps my punishment in the next world will be to hear them all played at once.

Brian Wittman's **xaphoon** is available by mail order at $45.00 including shipping anywhere in the world from Maui Xaphoon, P.O. Box 1163, Paia, HI 96779.



Brian Wittman makes the Maui Xaohoon®

INSTRUMENTS

DEAGAN ORGAN CHIMES

By Bart Hopkin

J.C. Deagan and Company is known as a manufacturer of marimbas and xylophones. In fact, it was the company's founder, J.C. Deagan, who probably did the most to popularize these instruments in the United States and Europe, and to standardize their form for use in popular, orchestral and chamber music. What is less well known is that the Deagan Company in its early days didn't stop with marimbas, but actually introduced an extensive line of new and unusual instrument types. Most of them are now pretty well forgotten, yet a few specimens are still around today. This article describes one of them: the *Deagan Organ Chimes* – one of the most interesting and sophisticated instruments from the early Deagan line.

A few months ago I got a letter from Art Sanders, owner of the Musical Museum, home of an excellent collection of mechanical instruments located in Deansboro, New York. The museum had been keeping a very rare, large set of Deagan Organ Chimes (sometimes also called *shaker chimes*) on loan from the instrument's owners in Connecticut. But the museum was unable to display the chime set properly. Figuring correctly that this was something right up EMI's alley, Art Sanders contacted me to ask if, with the owners' approval, EMI would be interested in keeping the set, making them accessible to people interested in seeing or studying them, and documenting them more fully. I said "Yes!", and soon I was in touch with Mrs. Floris Dinda and Mrs. Geraldine Kelly, daughters of Frank Tinker who had originally acquired the instrument almost 80 years ago. We agreed to a loan arrangement; the daughters Tinker generously provided a great deal of background information, and the Tinker Family Organ Chimes arrived at EMI's humble headquarters in the fall of 1992.

PHYSICAL DESCRIPTION

What, then, are Deagan Organ Chimes? For anyone familiar with non-western instruments, the easiest answer is to say that they look very much like a set of Indonesian angklungs, but made of metal rather than bamboo. Each individual note actually consists of four specially-shaped, tuned tube chimes of nickel-plated bell metal supported in a frame, as shown in Figure 2. One chime is tuned to a fundamental pitch; another an octave above that, and two more another octave up. At the bottom of each tube are two small tabs, 180 degrees apart, extending another half inch below the stopped end of the tube. When the chime is shaken, the tabs glide back and forth in a short groove cut into the wooden bottom of the chime frame, causing the chime to sound when the tab strikes the wood at either end of the short groove. The instrument taken as a whole is made up of a chromatically-tuned set of these frames, each providing one note in the instrument's range. The frames are designed to be hung on a large rack standing on the floor, which arrays them in front of the player in an immense keyboard arrangement with the naturals in a lower row and sharps and flats in a row above. The whole assembly stands over seven feet high and five or more feet wide. The player sounds the chimes by shaking the frames as they hang in the rack.

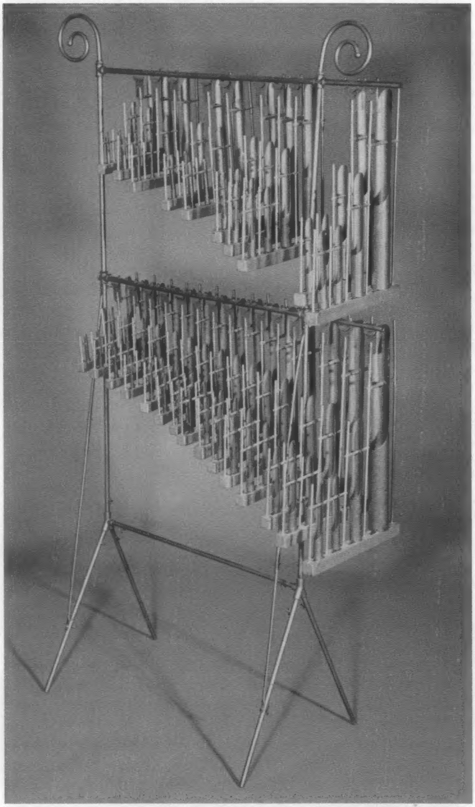


FIGURE 1: Deagan Organ Chimes, from the Arne B. Larson Collection at The Shrine to Music Museum, University of South Dakota at Vermillion.

I used the word *immense* a moment ago. The largest chime in the Tinker Family set is just over 3 feet long, pitched at E_3 (E below middle C). The range extends up chromatically just over three octaves to F_6 for a total of 38 pipes. The largest sets that Deagan made, according to old Deagan catalogs, contained forty-nine chime frames, for a range extending from G an octave and a half below middle C to G four octaves above that, with these largest sets requiring two floor racks. The floor racks were made with segments of rod and tubing in a utilitarian arrangement designed for lightness, portability, and ease of assembly and disassembly. Deagan's promotional literature declared that the frames could easily be removed from the rack and packed in a trunk "in but a minute's time" (a slight exaggeration, I suspect). Deagan also made a less elaborate version of the instrument, called *Aluminum Chimes*. These had three tube chimes in each frame rather than four, and the available range was slightly less.

I have said that the chimes were tuned chromatically, which is to say, they were tuned to twelve-tone equal temperament. The Tinker Family set, now 80 years old or more, is badly corroded in places, but the relative tuning seems to have held

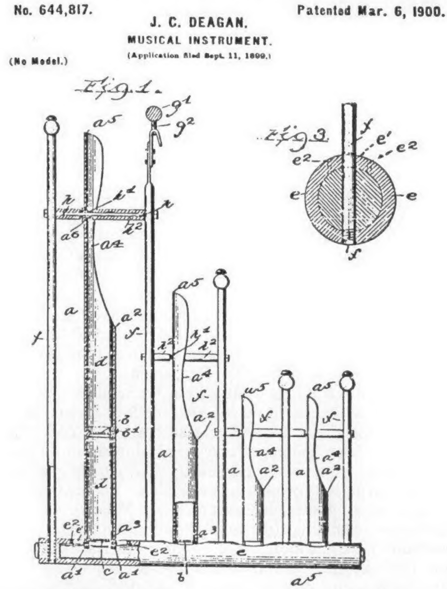
reasonably well for most, though not all of the chimes. A footnote in one of the promotional pieces for the instrument (this one from a Wurlitzer catalog ca. 1913) reads "All Deagan Instruments [are] tuned to International low pitch A-440 unless otherwise specified." Whatever the original tuning, the Tinker Family set is a bit below A-440, and I have heard that another surviving set is slightly sharp.

These tuning questions lead to one of the most important features of the organ chimes – a feature which Deagan's promotional literature, perhaps in the interests of trade secrecy, never mentions. The promotions speak of the rich, full tone of the chimes, but they don't say what makes the tone so rich. Here's the secret: each tube chime is air-resonance tuned. The resonant frequency of the air enclosed within the hollow tube matches the fundamental pitch of the ringing metal itself. The two reinforce one another, just as with a marimba bar and its resonator tube hanging below (something J.C. Deagan knew a bit about). The resulting tone is much fuller, louder, rounder, and less clangy than the metal tone alone. And while the air resonance frequency coincides with the fundamental in the metal tone, it does not match the metal's inharmonic partials. Thus, it enhances the fundamental and discriminates against the inharmonic partials – an effect that contributes to the clarity of pitch and the reduction in clanginess.

It is by means of the special cutaway shape of the organ chime tubes that the agreement is achieved between the metal chime tone and the air resonance. By removing more or less metal in the right places, an experienced chime tuner would have been able to adjust the air tone and the metal tone independently, with the goal of making the desired coupling between them at the desired pitch. Deagan describes the process in the patent he took out to cover the organ chimes (U.S. Patent #644,817; see Figure 3). The organ chime tube, unlike simpler tube chimes, is closed at the lower end. This lowers the air-resonance frequency by about an octave below what it would be if both ends were open, and makes the resonance a bit stronger and more focused. See the appendix at the end of this article for more on the air resonance tuning.

Many small variations and discrepancies exist among surviving sets of organ chimes, and they often don't display some of the features described in Deagan's original organ chimes patent. For instance, in the patent Deagan carefully describes special features for reinforcing the tabs at the base of each tube and transmitting the percussive impulse, yet the surviving Tinker set lacks these features. The patent also speaks of slidable end stoppers for tuning the air resonance, as well as dual resonance chambers (divided by the stopper set in the middle), both of which appear to be absent in most of the surviving instruments.

FIGURE 3: Drawings from one of the organ chimes patents, dated 1900.



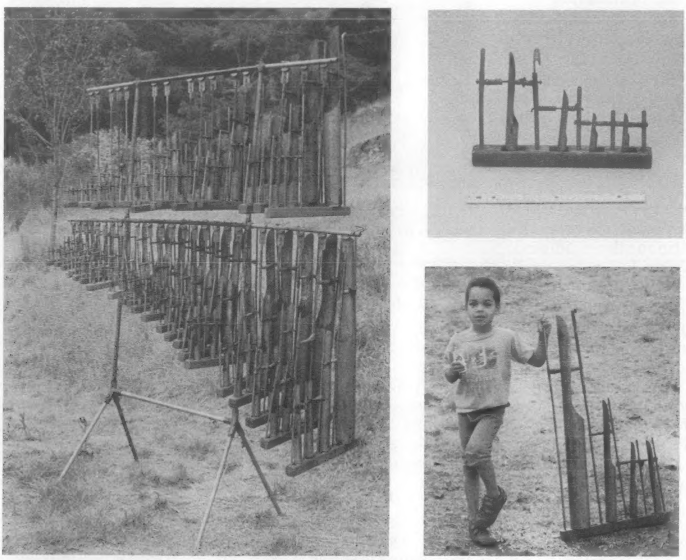


FIGURE 2: Left: The Tinker Family organ chimes

Right above: The smallest chimes of the set, shown with a one-foot ruler to provide a sense of scale.

Right below: The largest chimes of the set, shown with Shane to provide a sense of scale.

So what does a well-tuned set of organ chimes sound like? To get a mental sound-image, recall that, with the multiple-octave chimes within each frame, each note is doubled at the octave and again at the second octave. Remember too that the sound is produced by shaking — thus, the tone typically is not a single peal, but an ongoing series of rapid chimings at the sounding pitch. They run together in a continuous sound lasting for as long as the player continues to shake the frame, for a chiming tone which at the same time has the sustained quality of a wind or bowed string instrument. With its great clarity of pitch and the fullness of the air-resonated tone, the instrument rings out with good volume and carrying power, and a certain bigness of tone. It is tempting to draw comparisons to Indonesian instruments, both because of the organ chimes' physical resemblance to angklung, and the association of metal percussion with gamelan. Despite the organ chimes' western tuning, there is a quality to the sounding effect that does share something, subjectively speaking, with some Indonesian music. But the music that organ chimes have most often been used for, in keeping with the times and places they've been used, have been Christian hymns, Christmas carols, old-fashioned British and American popular songs, patriotic songs, and the like — all of which can be rendered charmingly on the chimes in one, two, even three or four parts.

ORIGIN AND HISTORY OF THE ORGAN CHIMES

John Calhoun Deagan, the original force behind J.C. Deagan Company, began making xylophones the latter years of the 19th century, completing his first "orchestral quality" xylophone in 1888. From that time until 1910, he made xylophones on order to the buyer's specifications. After 1910, standardized models with model numbers were introduced. In those early days Deagan also specialized in producing a wide range of hand bell sets. At the same time, he seems to have experimented with a variety of other innovative instrument types. The organ chimes were among the earliest of these, bearing U.S. patent dates of 1900 and 1901. The name *organ chimes* seems to have been created in part in reference to the sustaining quality of the tone when the chimes are continuously shaken, and in part to the octave duplication within each organ chime tone, by analogy to the composite nature of organ registrations.

How Deagan developed the organ chime design is anyone's guess, but the similarity in shape and overall conception to the Indonesian angklung is too strong to ignore. The bamboo angklung shape is virtually identical, as is the arrangement of multiple sounding elements within a framework, and the technique of playing by shaking. While angklungs in Indonesia are most often hand-held, they are sometimes rack mounted as well. The air-resonance tuning likewise can be found in well-made angklungs.

Circus World Museum in Baraboo, Wisconsin, houses an excellent collection of early handbills, postcards, newspaper advertisements and the like pertaining to circuses and other early popular entertainments. The collection is complemented by the private collection Fred Dahlinger, Jr., director of the Robert L. Parkinson Library and Research Center (affiliated with Circus World). Mr. Dahlinger has come up with newspaper advertisements placed in the *New York Clipper* in the years 1896 and 1897 by J.C. Deagan, featuring something called "Bamboo Chimes." Here, then, is a likely candidate for the missing link. On the other hand, Mr. Dahlinger also notes that The Circus World collection contains a Barnum and Bailey poster from 1889 showing (somewhat obscurely) something called the "East India, Melodious, Tubular, Metal Piano." This, he speculates may have been an early set of organ chimes or similarly shaken chimes — though whether it was the work of J.C. Deagan is anyone's guess.

Meanwhile, none of the surviving Deagan literature makes reference to angklung or any other precedent. Instead, it leaves


WELLS BROTHERS AND SMITH

... their career, having played thirty-two weeks and toured the country from coast to coast ...hout receiving one adverse criticism. They are now duplicating that record in the summer ...ks. The act is a high-classed one, appealing to all music lovers, and is a positive fea-

FIGURE 4: Magazine clippings from the collection of Fred Dahlinger. Both of these appeared in **Billboard,** dated 1905 and 1906.


FOR SALE,
$350.00
These Great 7 Octave
GOLDEN
Organ Chimes

HENRY B. RONEY,
2358 Indiana Avenue,
CHICAGO
Long Distance Phone, South 891.

the impression that the inventor developed the idea for the instrument entirely on his own. Nowadays there are plenty of books, recordings, films and museum collections making knowledge of exotic instruments reasonably accessible and commonplace in the west. A hundred years ago this was not the case. If J.C. Deagan had some knowledge of Indonesian instruments, he could easily at that time have borrowed their forms, even patented them as his own, without acknowledging their origins, without much concern that his sources would be recognized.[1]

It doesn't appear that a great many sets of organ chimes were manufactured and sold. Despite the undeniable appeal of their sound, they were a big, expensive instrument, and it likely would have been difficult to get many people to part with that much money for an exotic unknown. Where Deagan's marimbas gradually succeeded in creating a market niche for themselves, the organ chimes, along with most of the other innovative Deagan instruments, did not. For comparison: Of Deagan's *Nabimba*, an exotic mirliton marimba, only about fifty were ever made.[2] Statistics for the comparably priced organ chime have not come down to us, and so it's hard to say whether the numbers were very much larger.

Yet the instrument does seem to have found a place with at least a generous handful of novelty musicians and groups, and in some circuses.

The organ chimes remained available from Deagan at least until the early twenties. *Percussive Notes*, the magazine of the Percussive Arts Society, recently reprinted a set of Deagan catalogs from that period.[3] Catalog "H" from that set, titled *Deagan Musical Novelties* contains seven pages devoted to organ chimes and the related aluminum chimes, including pictures, descriptions and price information. (Pages from the catalog are reproduced inFigure 6.) The language, of course, is glowingly praiseful, as in "All the various musical instruments listed in this catalog were invented by J.C. Deagan, who is universally recognized as the world's greatest accoustician." As for the organ chimes, they are "universally conceded as being the greatest novelty instrument ever invented." The catalog gives information on twenty-eight available models of organ chimes and aluminum chimes, with Deagan model numbers between 5400 and 5530. Prices range from $95 (in 1920s dollars) for a set of 15 aluminum chimes in the upper range, to $650 for the big 4-octave set of organ chimes on two floor racks.

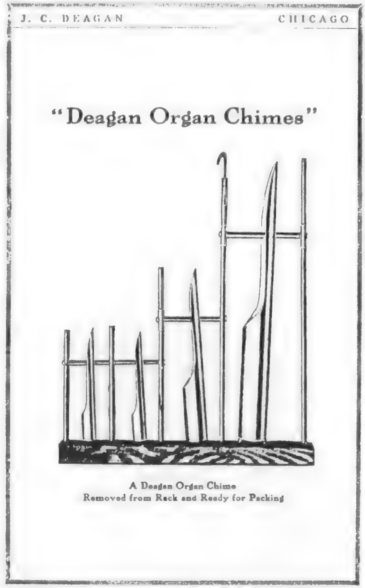
I have not been able to ascertain when Deagan Company stopped making organ chimes. The entire line of "novelty instruments", among which the organ chimes were prominent, surely had long been out of production when Deagan Company became a division of Slingerland Drum Company in 1977. In 1986 – to bring the story up to date – the Deagan name and all that went with it was sold again, to Yamaha. Yamaha has continued to sell some Deagan chimes and orchestral bells, but the remainder of the Deagan line has been discontinued.

SURVIVING INSTRUMENTS

In the process of researching this article, I have gotten word of about a dozen surviving sets of organ chimes in various locations across the U.S. How many more there may be, I cannot say. Here are some notes on a few of the remaining sets.

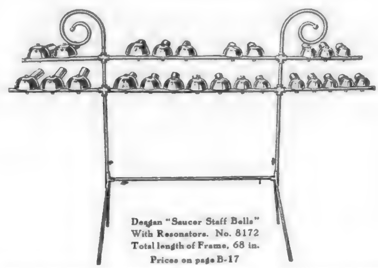
The Frank M. Tinker Singing and Dancing Orchestra, also known as Tinker's Singing Orchestra, flourished from 1904 through 1938 in Massachusetts and neighboring states. Frank Tinker was the orchestra's drummer; his wife Frances E. Tinker played saxophone, and at the organ chimes (at least during the time period around 1930) was one Wilfred F. Oldale. Mr. Tinker purchased the Organ Chimes set shown in Figures 2 and 7 sometime around 1915, and they quickly became a featured instrument in the orchestra. Surviving photographs show a group of ten players, with instruments including banjo, piano, saxophones, trumpet and trombone, string bass, and drums. The group also played at least two other unusual Deagan instruments: The saucer bells (Figure 6, below) was a tuned bell set mounted on a floor rack. Fancier versions had small tubular air resonators attached directly to the side of each bell. The Unaphone or Una-fon reportedly was a keyboard-operated electro-mechanical metal-bar

FIGURE 6: A page from an early Deagan catalog. Below, a picture from the same catalog of another Deagan instrument used in the Tinker Orchestra, the Saucer Bells.


J. C. DEAGAN CHICAGO

"Deagan Organ Chimes"

A Deagan Organ Chime
Removed from Rack and Ready for Packing


Deagan "Saucer Staff Bells"
With Resonators. No. 8172
Total length of Frame, 68 in.
Prices on page B-17

FOOTNOTES, this page

1. Deagan did, in a sense, acknowledge some of his antecedents with his bar instruments, by calling them by names reflecting their origins (e.g., marimba and nabimba), but he doesn't seem to have divulged their origins further. The nabimba, for instance, was a marimba-like instrument with mirliton membranes attached to the resonator tubes to increase the volume and add a distinctive tone quality. This was an idea taken directly from both African and Guatamalan marimbas, but Deagan actually patented it for himself and presented the idea in his catalogs as a great innovation.

2. This figure comes from Frank M. McCallum's **Book of the Marimba** (Carlton Press, 1969).

3. **Percussive Notes Research Edition**, March/Sept 1986. This is a fascinating set of documents, highly recommended – write the Percussive Arts Society for information on availability at PO Box 25, Lawton, OK 73502-0025.

FIGURE 7, above and below: Billboards for "Tinker's Famous Sin estra"

xylophone with resonators.

After the orchestra disbanded, the Organ Chimes set remained in the Tinker family. For many years they were packed away in storage. In 1990 two of Frank Tinker's daughters, Mrs. Floris Dinda and Mrs. Geraldine Kelly, arranged to send the chimes to Art Sanders' Musical Museum in upstate New York, and from there, as described earlier, they found their way to EMI.

Marion B. Cox, in Bountiful, Utah, has maintained a set of Organ Chimes in good condition, and plays them with extraordinary clarity, precision and virtuosity. He has performed on them intermittently since they came into the Cox family in 1934, when he was 12 years old. Mr. Cox continues to provide the musical sound of Deagan Organ Chimes on special public occasions and for friends and family in his home.

During the years 1935-1946, the Cox chimes were the star attraction of a touring musical group formed by Mr. Cox's father, Edward Cox, then of Salt Lake City, Utah. "The Chimers" performed at hundreds of schools and other facilities in Utah, Idaho, Oregon, Washington, Nevada, Arizona and California, and in Utah and Idaho in 1952-1962. During the earliest years, the chimes were played by Mr. Cox's sister, Bernice Cox (Sly), who also gave humorous readings, and a cousin, Eva Cox, widely acclaimed as a world-class yodeler as well. By age 17, Mr. Cox had gradually developed a repertoire of solo music on the chimes that included three and four-part harmony, then toured with the group as chimes and vocal soloist in 1938.

The elder Cox was an accomplished musician, music teacher, and composer. He acquired the Deagan Organ Chimes from George Barzee, a Salt Lake City piano tuner. Mr. Barzee received them in partial payment of tuning services for Ringling Brothers and Barnum & Bailey Circus while it was in Salt Lake City in 1933. Based on writing stamped on a C chime pipe, "J. C. DEAGAN, CHICAGO, MAR 16-1900," it is thought this instrument was made as early as 1900.

Mr. Cox has personally seen one other set of Deagan Organ Chimes. He was living in Hemet, California, in 1949, when he and his wife, Joyce, were startled to see Deagan Organ Chimes standing on a downtown city sidewalk. An itinerant minister was using the chimes to help promote a revival meeting. Mr. Cox then age 28, excitedly told the minister he owned a similar set of chimes. The minister was skeptical and did not share Mr. Cox's enthusiasm, but invited him to play. A large group of Saturday afternoon shoppers gathered to hear "The bells of St. Mary's," and the minister had a captive audience to invite to his revival meeting.

Mr. Cox taught most of his children to play duets with him on the Deagan Organ Chimes during their teen years. His sons Paul, Gary, Dale, Dwight, and daughter Jana, participated in public. Mr. Cox has given hundreds of public performances, including a memorable series in the rotunda of the Utah State Capitol Building – bringing a new dimension to the sound of Deagan Organ Chimes music as it reverberated for several seconds from the marble walls and hard-surface floors throughout the cavernous building.

Circus World Museum (426 Water St., Baraboo, WI 53913) has three sets of organ chimes. The largest of them, a 27-note set, is demonstrated in performance by a museum docent three times a day. It was previously used by novelty performer Larry Benner of Miamisburg, Ohio. One of the smaller set has been used in a wagon for parades.

Among additional surviving sets not privately held are one in excellent condition at the Shrine To Music Museum at the

FIGURE 8. Above: an early poster for the "The Chimers." Below: the same chimes set played by Marion B. Cox and son Paul in 1967.

University of North Dakota (414 East Clark St., Vermillion, SD 57069-2390) (this is the beautifully preserved set shown in Figure 1); one at The House on the Rock (Highway 23, Spring Green WI, 53588; phone (608) 935-3639); and one at Purdue University.

Special thanks for assistance with this article to Mrs. Floris Dinda, Mrs. Geraldine Kelly, John G. Tinker, Art Sanders, M.B. Cox, Margaret Downey Banks of the Shrine to Music Museum, the Percussive Arts Society, Fred Dahlinger Jr. of Circus World Museum, and Greg Filardo.

Anyone interested in seeing and hearing the Tinker Family Organ Chimes should contact Bart Hopkin at EMI.

Appendix

AIR RESONANCE TUNING FOR CHIMES

As part of my research for writing this article, I spent a few hours in the shop experimenting with air resonance tuning for chimes. What follows is certainly not the last word on the subject, but here are some notes on what I learned.

First, some background, starting with a discussion of simple cylindrical tubes. (We'll get to the more elaborately shaped organ chimes in a moment.) The air enclosed within a hollow cylindrical tube will have certain natural resonance frequencies. These are the frequencies at which the air is naturally inclined to oscillate, once excited. You can determine what these frequencies are by finding some way to excite the air inside. An easy way to do this is by blowing flute-style over the edge at the end of the tube. As you do so, listen to hear what pitch dominates in the somewhat breathy tone that results. Normally there will be a lower pitch which dominates in the sound. That's the lowest resonance frequency, the fundamental. Some overtones, representing additional resonance frequencies in the air column, are usually present as well, but they tend to be subtle and more difficult to hear.

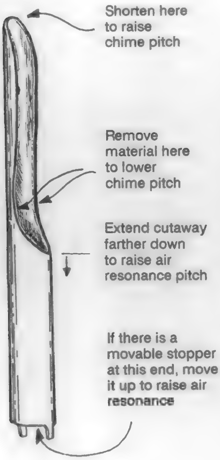
The metal of the chime itself also has its resonant frequencies — the ones you hear ringing out when you strike it. These likewise consist of a fundamental mixed in with overtones, blending together to form the chime's composite timbre. If one of the air resonance frequencies happens to agree with one of the metal chime frequencies, then the chime tone will excite the air resonance when the chime rings. The two will reinforce each other, and the overall result will be a stronger, richer sound from the chime. The best results usually come about when the fundamental of the chime tone matches the fundamental air resonance, rather than matches between the overtones. That's partly because the fundamental air resonance is usually the strongest, and so gives the richest result. It's also because in most cases (though not all), it is the chime's fundamental that we most want to hear, and so it helps to have the air resonance bring out that tone selectively. With many chimes, especially metal chimes in the lower ranges, the overtones tend to be overly strong relative to the fundamental. Chime overtones are non-harmonic. Their prominence in the tone gives the timbre a clangy quality, and creates ambiguity in the tone's perceived pitch sense. A rich air resonance at the fundamental helps alleviate those problems, as well as increasing volume and lending a special fullness to the sound.

There are actually two possible resonance systems in hollow cylindrical tubes. One is the resonance you get when both ends of the tube are left open. The other is the resonance you get when one end is stopped, by means of some sort of solid end-covering, or perhaps something like a cork. The fundamental for a stopped-end resonance is a little less than an octave lower than the fundamental for the same tube with both ends open.

For cylindrical metal tube chimes of typical dimensions, the fundamental air resonance is well below the fundamental chime tone, for both open and closed tubes. The challenge then is to think of ways to either raise the air resonance or lower the chime tone without at the same time defeating

the purpose by causing a parallel change in the other. One way to do this is to try using a very slender tube (the skinnier and less rigid the tube, the lower the chime pitch). For various reasons which I won't enumerate, this approach is impractical and yields poor results anyway. Another way is to give the tube an end stopper in the form of a cork, and then slide the cork the right distance up into the tube. The idea is to shorten the air column length to the point where the air resonance matches the chime tone. For typical chime dimensions, it turns out that this means sliding the cork to a point where the air column constitutes only a small percentage of the overall tube length. For I don't know what reason, this conveniently simple and seemingly promising approach did not yield enhanced resonance when I tried it. Maybe someone else will have better luck with it.

The third approach — and this is the one that has proven most successful — is to somehow open up or cut away part of the tube, so that the effective air column is substantially shortened while the overall tube length for chiming purposes is less affected. This is how the organ chimes work, as well as the bamboo angklung. In these instruments, one side of the chime tube is sliced away over a large part of the tube length, leaving only a short portion of the original air column intact. Removing all that material also affects the chime tone, but not in a fashion that parallels the rise in the air resonance tone. Removing mass from one end of the chime tends to raise the chime tone, but removing material near the center tends to reduce its rigidity in the region where it needs to flex, which lowers the chime tone. Thus, by the shaping of the cutaway, you can controllably tune the chime tone without affecting the air tone. Meanwhile, you can tune the air tone by continuing the cutaway farther along the tube, thus altering the length of the enclosed air column. Another trick is to use a slideable stopper such as a cork for the end-stopper, and tune the effective air column length by sliding the cork a short distance farther in or out (I found this to work nicely with the organ chime configuration, even though, as mentioned above, I didn't work with the simple tube). On the Deagan organ chimes the cutaway typically extends to about half the tube length for the bigger, lower-pitched chimes, and up to about 60% or more for the smaller ones. The depth of the cut is about 2/3 of chime diameter. Bamboo angklung — those that I've been able to check anyway — show similar lengths of cut, but depths of only about 1/2 of tube diameter.



When I made a few Deagan-style metal chimes, I found that altering the original tube shape by making the cutaway seriously undermined the clarity of the chime tone. Tuning the air resonance then brought back some of the tone, but I remain envious of both the angklung makers and the organ chime makers for having somehow retained excellent clarity in the chime tone even with the cutaway shape.

Altering the tube shape by making the cutaway means that the tube is no longer symmetrical all around. As a result, the chime manifests different modes of vibration depending upon the angle of the strike. It produces multiple fundamentals — struck from the side it sounds one tone; struck from front or back it produces another. Angklung and organ chimes are mounted in their shakers in such a way that the percussive impact always comes from the right direction to excite the desired mode and minimize the audible effect of the other tones.

While I was trying out the principles of organ chime and angklung tuning, I also explored several other ways to alter the form of a tube chime so as to bring up the air resonance. Some approaches yielded so-so results, and some proved quite satisfactory. Let me describe the most successful and conveniently do-able of the the techniques tried.

It occurred to me that you can treat a cylindrical metal tube chime like a flute: drill toneholes along the side to raise the air resonance pitch. Typically, when you've drilled a row of holes over about 60 or 70% of the overall tube length, you can achieve a match between the open-tube resonance pitch and the chime fundamental, and the tone will ring out with noticeably increased fullness and volume. You can verify the effect, once you've got the match, by striking the chime and then gently blocking and unblocking the first tonehole with a finger: you'll get a wah-wah effect, much like the vibrato of a vibraphone, as the resonance match is alternately un-done and then restored.

A few notes on the process: Don't bother trying to shortcut the situation by drilling a single tonehole far up the tube. There are acoustic reasons why you need the row of open toneholes, just as on a flute. But the sizing and spacing of most of the toneholes is immaterial; I suggest making them about 1/2 of tube diameter and an inch or an inch and a half apart for a typical-sized chime. Start the series near one end of the tube, and proceed from there, checking the air resonance against the chime tone after drilling each new hole. The last hole you drill — the one closest to the hole-less end — is the one that will matter most in determining the air resonance tone. The closer to the hole-less end it is (the shorter the air column in the hole-less part of the tube) the higher the air resonance will be. Also, the larger that hole is, the higher the resonance. So: when you find you are drawing close to matching the two resonances, drill the next hole at what seems like a reasonable location, but make it small. This should yield an air resonance still a bit low. Then gradually enlarge it until you get the match. The strongest tone will usually come about not as expected at a perfect match, but rather when the air resonance tone is very slightly below the chime tone.

Adding the holes will make the tube slightly less rigid, and so lower the chime pitch slightly. If you place the holes in a straight line, it also makes the tube weaker along one axis than another. The result, once again, is to give the tube two fundamentals depending on the angle of the strike, making it henceforth necessary always to strike from the right direction. You can try spiraling the holes or otherwise altering their location around the cylinder, so that the weakening doesn't happen predominantly along one axis; this may alleviate the dual fundamental problem.

The toneholes trick seems to work best with chimes whose length-to-diameter ratios allow them to have a good tone in the first place. It is only marginally effective in improving the sound of a chime that is too long and thin, making it weak in the fundamental.

EXTENDED WIND INSTRUMENTS FROM WARREN BURT AND BRIGID BURKE.

Text by Warren Burt
Photos by Carolyn Connors

Inspired by Ernie Althoff's prepared saxophone (an alto sax with 6 feet of pvc tubing between the mouthpiece and the body of the instrument) and Aloysius Suwardi's water suling (as shown in *Leonardo Music Journal*, vol. 1, no. 1, p.21), Brigid Burke and I began experimenting with inserting different bits of plastic tubing between the parts of our various wind instruments. Different harmonics, multiphonics and microtonal scales all became available with the different modifications.

PHOTO 1 (below) shows the collection we used for our "Improvisation for Tube Extended Wind Instruments," which we presented at the 1992 Spontaneous Generations improvisation festival, an annual festival held in Melbourne, organized by choreographer Al Wunder, that showcases dance, drama, music and cross disciplinary work. From the left are: 3 clarinet parts; a flageolet with a small tube extension at the end; an open-holed "folk piccolo" with a small tube between mouthpiece and body; a flageolet with 2.5 meters of narrow plastic tube extension; a flute with an extension between the mouthpiece and the body; and the "triple-fipple extended harmonic water flute," made from 3 masking taped flageolets, plastic tubes, and a plastic yogurt container.

PHOTO 2 (above): Brigid playing one of her extended clarinets. The tubing is stiff, but still flexible, resulting in some fairly floppy instruments, which were quite difficult to hold, let alone play. To get the breathy multiphonics this instrument produced, Brigid found the "locked-knee technique" to be especially effective.

PHOTO 3 (right): Me playing the extended flute. Another example of aerophonic floppiness. I could just manage to rest the mouthpiece on my lip while I used my right hand to play the keys, but too much mouth motion had the mouthpiece waving in space while I chased it with my lips.

PHOTO 4 (left): A solo shot of the "triple-fipple extended harmonic water flute". A single long plastic pipe is used to carry air into the plastic yogurt container, which is half filled with water. This air pipe has a snug, but not fixed insertion into the lid, so that it can be pulled up and down, in and out of the water, resulting in either bubbles breaking up the air stream, or not. Three plastic tubes extend from just inside the lid of the jar to three flageolets, which have their tone-holes taped up, so they only function as fipples. The tubes are also taped together for ease of playing. Each flageolet is then extended with a further piece of plastic tube. Each pipe provides a different harmonic series, controlled by breath pressure. The harder you blow, the higher the note in the harmonic series of that pipe. By using your fingers to close and open the fipples, you select the pipe(s) you want to play.

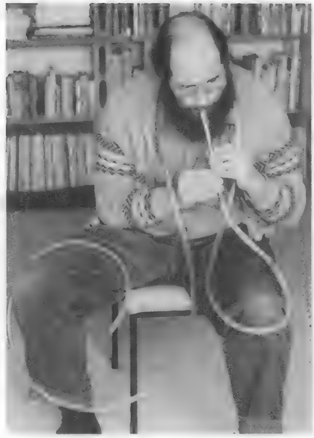


PHOTO 6 (above): When you close all its tone-holes, this long-tube extended flageolet allows you to play very narrowly spaced high harmonics which change with only a slight variation in breath pressure.

PHOTO 5 (below): Duo shot of us improvising. The poster in the background is by Brisbane concrete poet Nicholas Zurbrugg and is an ironic improviser's manifesto: "Intuition? intolerable! (deep down you know I'm right)."

PHOTO 7 (above): Another duo shot. Note the contrast of the "cross-lapped" and "locked-knee" playing positions.

CIRCUIT-BENDING —and— LIVING INSTRUMENTS

THE SOUND DUNGEON

BY Q. R. GHAZALA

My experiment had gone awry. Thick smoke was rolling up the back of the house by the time my grandfather stepped around the corner. The coffee can in which the paraffin and string had been placed was now ablaze, over-heated by the small flame beneath it. In the Weekly Reader article from school there had been a tantalizing description of a 'tin-can telephone', the containers connected not with an ordinary string, but with a waxed string. I had kite-string, I had wax, and I had a pretty bad fire in the back yard.

Grown-ups know things that kids don't. Things such as ~ "You can't extinguish a can of furiously burning wax and string by blowing on it." ...a lesson I was in the process of learning when a shovel-full of sand abruptly killed the flames.

My grandfather was kindly tolerant of little boys antics, an attitude for which I often found myself feeling grateful. After the lecture on fire-smothering he soon reappeared carrying a couple empty cans and a whole ball of real waxed string. We had soon constructed a fine home-made telephone that was capable of carrying our voices about thirty feet, or from the bird bath to the charred spot on the driveway just outside the garage door.

So went my early experience in the art of crafting an acoustic diaphragm, in that instance a resonator system meant to amplify a very weak sound...

Circuit-bending and Living Instruments,

by Q.R. Ghazala

THE SOUND DUNGEON

(continued from previous page)

Looking back, it was the crank-wound phonograph of the 20s that so successfully brought this principle to the public attention. These early record players, descendants of the Edison wax recording cylinder, took full advantage of this amplification principle. Acoustically, the small diaphragm that connected to the phono needle can be viewed as the "pre-amp", the "power-amp" being the horn to which it was chambered.

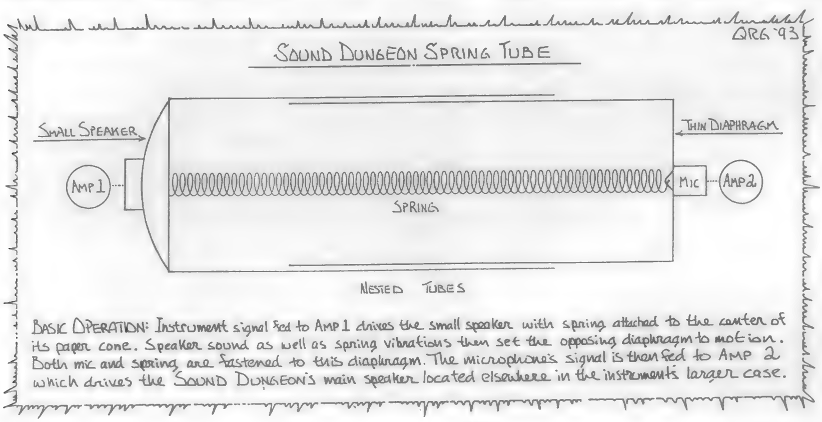
In musical instruments we find nearly the exact same mechanism at work in the unusual English "phono-fiddle".[1] Half trumpet, half fiddle, it was developed in an attempt to increase the violin's volume so it could be better heard in early orchestral recordings. Its strings rest upon spine like bridges that connect to a "phono" diaphragm which, as above, is channeled to a horn. Many of these instruments were made in London which is where I found mine hiding in the shadows of a cluttered secondhand shop. A simple one-stringed version with inlaid fret marks and streamlined brass horn, it's marked "A. T. Howson, London.". Without straying too far from this acoustic mechanism we see the same amplification principle at work in the more common banjo as well as many other chordophones. My instrument, the Sound Dungeon, looks to this principle for half of its design.

Q.R. Ghazala and helpers in the shop. Photo by Mark Shaw

After amplification the next most important use of resonators in musical instruments is, to me, the more interesting, the aspect upon which the second half of the Sound Dungeon is based. It's also the aspect which in fact ties such seemingly unrelated instruments as the kazoo, sitar, and the Ondes Martenot together, as well as many others. In these cases amplification is not the problem addressed by the secondary resonator. The kazoo's paper membrane, the sitar's drone strings, and the Ondes' "metallic" speaker all exist instead to modify the tone, or harmonics, of the primary voice. Whereas these instruments have their sound modifiers built-in, the Sound Dungeon is a stand-alone unit into which any electronic or miked instrument can be fed. No, not a musical instrument itself, but I mention it here for a couple of reasons. First, outside of specialty speakers (folded baffle, rotating radiator, spaced or moving louvre, etc.) and true reverb chambers (electromagnetic plate or spring primarily) to which the Sound Dungeon is related, independent sound-control enclosures seem relatively unexplored. And second, the Sound Dungeon incorporates, like many circuit-bent[2] instruments, a circuit that can be found quite often in the used-goods market place. Though the Sound Dungeon merely touches upon the possibilities of such devices, it does create distinct effects and might inspire more involved projects.

Picture a couple nested tubes, one sliding securely within the other as in a telescope. One end of the tube system is closed by a speaker which fires into the expandable chamber. At the other end of the enclosure is a plastic diaphragm with a small microphone attached to its center. And directly connecting the paper cone of the speaker to the diaphragm that the microphone is fastened to is a long, supple, tightly-coiled spring. This tube is the heart of the Sound Dungeon system and can be seen emerging from the open end of the larger metal case (see photo and drawing).

The Sound Dungeon employs two separate amplifiers, each with its own speaker. An external input signal (line or mic) delivered to the first amp will drive the speaker connected to the end of the tubular chamber. This is the speaker with one end of the stretched spring glued directly to its diaphragm. The second amplifier is fed by the internal signal from the microphone at the opposite end of the spring and tube. After amplification this



1. From the editor — The phono-fiddle is a close relative of the (perhaps better known?) Stroh violin. Hopefully one of these days we will get an article on these unique instruments into EMI.

2. Circuit-Bending refers to the process of creative short-circuiting by which standard audio electronics are radically modified to produce unique experimental instruments. A further description of these techniques can be read in EMI Volume VIII #1, Sept. 1992.

Left: Electro-acoustic spring chamber by Mattel Electronics

Below: The Sound Dungeon

modified signal drives a second, larger speaker located at the left end of the case. Very simple, very straight-forward.

Though the similarities between this system and the usual "spring-reverb" are obvious, the differences play a very important role. The muddy sound of the familiar spring-reverb is overcome by the replacement of its miniature output transducer by amp #1's small speaker whose full frequency range (rather than the limited range the spring can carry) is transmitted to the opposing mike by means of the air-column within the expandable tube. Thus the signal from the spring which this same speaker excites is acoustically (rather than electronically) mixed with the speaker's direct output as it is fed to the microphone and the second amplifier. You can also imagine the unusual phase relationships that result from the microphone itself moving in the sound-stream, concordant with the diaphragm to which it is attached.

More importantly, unlike traditional spring-reverbs, the Sound Dungeon's spring can be tensioned from very slack to very taut. (Sagging springs in reverb systems are considered quite a taboo. This is one of the reasons most units employ short springs, though there are a few reverb pedestals containing coils several feet in length. The vertical rather than horizontal orientation of the springs allows the greater length without the worry of the spring drooping onto other system components.) However, with the sound dungeon it's when the tube is collapsed and the spring becomes very limp that the most interesting things start to happen. As the spring begins to droop within the tube, between the speaker and the mike, its coils begin to touch each other at their tops. The reverb then takes on a special buzzing or humming characteristic, making it sound like an ethereal shawm or some kind of other-worldly mirliton (as in the 17th century Eunuch or onion flute, basically a grand ornamental kazoo). And with the tube collapsed fully, the spring drooping onto the inner walls of its chamber, any sound introduced into the cylinder becomes mixed with an assortment of deeply reverberant parallel tones... like an ominous balanced or ring modulator. The noises produced in this way are both clangorous and watery, echoes seemingly disintegrating into the dripping of dark catacombs. It was these tonalities that inspired the Sound Dungeon name.

In addition, by carefully adjusting the gain of both amps, it's possible to create a feedback/sustain chamber due to the positions of the internal speakers and microphone. These "sample and hold" effects can be had over the entire spring-tension range, prompting some very interesting, harmonically complex wave-forms. Inputs, outputs, and source-switching controls provide even more patching possibilities ... signal looping, stereo drive/splitting, wet/dry mixing outputs, and the like.

As I mentioned before, the Sound Dungeon is built around a spring chamber made as a children's toy, great for experiments, that frequently sells for one to three dollars at various thrift and second hand shops. Truly a bizarre device, in this toy a wolf-headed cylinder containing voice-diaphragm, spring, and microphone, is connected by a wire to a small amplifier housing (see photo), all of which is contained within a large plastic mountain designed to look as spooky as the manufacturer could muster. Mattel Toys produced these by the thousands in the early – mid 80s.

To create a basic Sound Dungeon from one of these devices, all that's needed is an additional primary amp whose speaker will replace the voice diaphragm (with connected spring) inside the top of the wolf-cylinder, which itself could be replaced by any of various tube systems. The spring would now be connected to the new speaker, simple as that. Choice of additional controls would be up to the imagination of the builder.

I would like, for a moment, to acknowledge the fact that many people are reluctant to embrace circuit-bending assuming that an audio instrument built from an altered toy still remains a toy. As the increasing number of Incantor[3] owners will attest, nothing could be further from the truth. Circuit-bending can unleash a vast assortment of musically-valid compositional elements, be they voices or playing techniques. As with the Sound Dungeon, circuit-bending usually represents a distinct transition of performance, the original plaything but a drab cocoon compared to what might take flight.

You may remember the "Rainbow Guy," the fellow that named the Odor Box whom I mentioned in that earlier article. One day, long ago, he and I were sitting in my front yard in our old neighborhood. We were watching a fellow walking down the street toward us. As he approached we could see he was carrying a very large hammer in his hand. The stranger stopped not far from us and, shading his eyes from the sun, looked up to study the top of a tall telephone pole. In a swift moment he swung the hammer as hard as seemed possible, striking the pole and then immediately pressed his ear to it. A broad, satisfied grin spread across his face as we, transfixed, looked on. He stood there waiting, waiting... and then nodding his head in satisfaction he moved on... to the next pole. Before he disappeared we were off to find a hammer of our own.

If you've tried this with the right poles you know that the shimmering metallic echoes created by telephone wires of different tensions and thicknesses phasing back and forth together can create a splendid array of sounds. On another occasion, while hiking a riverside pathway through tall green nettles and

3. Incantors are circuit-bent Texas Instruments' educational toys of the "Speak & Spell" series.

yellow flowering jewel-weed, I rounded a bend to find the source of a roaring that I had heard growing steadily louder as I approached along the pebbled shore. Here the water was tumbling over an old concrete dam, only four or five feet high, but stretching the full width of the river. For canoeists this was definitely a portage point, and to assist those unwary drifters who came upon the drop by surprise a steel cable had been strung across the water. The cable was stretched about three feet above the rushing surface maybe ten feet before the dam, spanning from shore to shore. From this cable hung numerous chains all of which danced wildly in the turbulent stream. The idea, of course, was that the panicking canoeist could grab a chain, and therefore the cable, pulling the craft ashore while affording the fish a good laugh and the chance at a potato chip or two.

I'm sure you've guessed my interest in this situation. All expectations were delightfully rewarded when I press an ear to the supporting iron pole which held the cable taut. Each of the chains, their many links jingling together, transmitted waves of scintillating metallic sounds up to the supporting cable at the many different points of junction. The multitude of oscillations this produced in the steel strands created as fascinating a cable sound as I've ever heard. I'll leave it to you to imagine the tonal complexities brought forth by such elaborate means of modulation.

The Sound Dungeon is one of several devices that I've built inspired by listening to poles and other resonant structures having cables or plates attached. (I often carry a stereo "embedded-microphone" kit for recording such sounds. Brass-encased mini electrets plus wood hand-bore, pre-amps, headphones, recorder... for bridges, poles, buildings, dead trees, etc.)

Though the Sound Dungeon is admittedly a very simple device, to me it suggests electro-acoustic chambers far outside the territory of standard reverb. It seems resonant cavities could be built containing an untold number of different materials sensitive to vibration ... glass, metal, paper, wood, plastics. Sounds could be fed through tight densities of reverberant substances, like great masses of taut metal strings. Sounds could be sent into and retrieved from moving water, itself containing resonant objects in motion. I suppose even the turbulent heated air rising from several miles of summer pavement could be viewed as a chamber, optical sound signals passed through it for modulation.

Wouldn't it be interesting to someday be able to play an instrument through, perhaps, an "ocean" chamber, a "cornfield" chamber, or even a "Bali Marketplace" chamber, and hear the notes intermingle somehow not just with the illusion of space, as it is with reverb, but also with illusory overtones and accompaniments suggestive of much more specific environments? With that thought I will close this writing, trusting that EMI readers might share additional design concepts for further exploring experimental sound chambers.

The author will accept assignments to construct any of his devices covered in EMI, circuit-bent or original, although availability of specific electronics for bending is often uncertain. Contact Q. R. Ghazala at Sound Theater, ECHO 241, 7672 Montgomery Rd., Cincinnati, Ohio 45236.

Computer assistance by Tony Graff, artist and painter.

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RELATING TIMBRE AND TUNING

by Bill Sethares

"Clearly the timbre of an instrument strongly affects what tuning and scale sound best on that instrument" — W. Carlos

Near the start of the article that follows, Bill Sethares makes an assertion which most readers will find counter-intuitive, perhaps implausible. The assertion, supported by data from several studies, concerns the conditions for consonance between pure sine-wave tones. This sine-wave consonance theory underlies the math that supports the ideas and procedures presented in the rest of the article. Whatever your response to the initial assertion, do read on: the ideas that follow make intuitive sense, and they are well worth exploring.

Bill's article is more technical than most that appear in EMI. I encourage anyone interested in scale and timbre, even those without a mathematical background, to read through anyway. Many of the underlying principles will emerge even for one who doesn't follow all the detail. Computer people, notice the BASIC program at the end of the article, ready to put principle into practice.

INTRODUCTION

If you've ever attempted to play music in weird tunings (where "weird" means anything other than 12 tone equal temperament), then you've probably noticed that certain timbres (or tones) sound good in some scales and not in others. 17 and 19 tone equal temperament are easy to play in, for instance, because many of the standard timbres in synthesizers sound fine in these tunings. I remember when I first played in 16 tone. I had to audition hundreds of sounds before I found a few good timbres. When I tried to play in 10 tone, though, none of the timbres in my synthesizers sounded good. This article explains why this happens, and shows how to design timbres and scales that complement each other. This suggests a way to design new musical instruments with unusual timbres that can play consonantly in unusual scales.

The principle of local consonance describes a relationship between the timbre of a sound and a tuning (or scale) in which the timbre will sound most consonant. The principle answers two complementary questions. Given a timbre, what scale should it be played in? Given a scale, how can consonant timbres be chosen? The ability to answer such questions will likely impact the way we design new musical instruments.

The presentation begins in the next section with an overview of the work of several acousticians, who have shown that people judge the consonance and dissonance of intervals composed of pure sine waves fairly consistently. These judgments are averaged into a "dissonance curve" which is used to calculate the dissonance of complex timbres. The results of such calculations agree well with the normal (musical) notions of consonance and dissonance when applied to harmonic timbres. Thus unisons, octaves, fifths and fourths are highly consonant while seconds and sevenths are relatively dissonant.

Of course, this measure of consonance and dissonance can also be applied to other (non-harmonic) timbres, and the succeeding sections show how to design timbres and scales. Several concrete examples follow, including finding scales for nonharmonic timbres (the natural resonances of a uniform beam such as a glockenspiel or a flat marimba bar, "stretched" and "compressed" timbres, FM timbres with noninteger carrier-to-modulation ratios), and finding timbres for equal tempered scales. This article is a less technical presentation of my paper "Local Consonance and the Relationship Between Timbre and Scale," which contains the mathematical details. See the reference section at the end of this article for details of all articles and books referred to in the text.

WHAT EXACTLY IS CONSONANCE?

The standard musicological definition (see your favorite dictionary) is that a musical interval is consonant if it sounds pleasant or restful; a consonant interval has little or no musical tension or tendency to change. Dissonance, on the other hand, is the degree to which an interval sounds unpleasant or rough; dissonant intervals generally feel tense and unresolved.

In *On the Sensations of Tones*, Helmholtz offers a physiological explanation for consonance that is based on the phenomenon of beats. If two tones are sounded at almost the same frequency, then a distinct beating occurs that is due to interference between the two tones (piano tuners use this effect regularly). The beating becomes slower as the two tones move closer together, and completely disappears when the frequencies are identical. Typically, slow beats are perceived as a pleasant vibrato while fast beats tend to be rough and annoying. Recalling that any timbre can be decomposed into sine wave components, Helmholtz theorized that dissonance between two tones is caused by the rapid beating of various sine wave components. Consonance, according to Helmholtz, is the absence of such dissonant beats.

More recently, R. Plomp and W.J.M. Levelt examined consonance experimentally, by generating pairs of sine waves and asking volunteers to rate them in terms of their relative consonance. Despite considerable variability among the responses, there was a simple and clear trend. At unison, the consonance was maximum. As the interval increased, it was judged less and less consonant until at some point a minimum was reached. After this, the consonance increased up towards, but never quite reached the consonance of the unison. Plomp and Levelt called this tonal consonance, to distinguish it from musical consonance and from Helmholtz' beat theory.

Figure 1 shows an averaged version of a dissonance curve (which is simply the consonance curve flipped upside-down) in which dissonance begins at zero (at an "interval" of a unison) increases rapidly to a maximum, and then falls back towards zero. The most surprising feature of this curve is that the musically consonant intervals are undistinguished - there is no dip in the curve at the fourth, fifth, or even the octave.

Many people find this counter-intuitive, even disturbing. Since nearly all practical musical experience is with complex timbres, we rarely have the opportunity to perceive the tonal consonance of figure 1 directly. Nonetheless, this is a well accepted result in the psychoacoustic literature, and can be duplicated by anyone with access to a sound source capable of generating pure sine waves.

Reassuringly, the familiar notions of musical consonance can be explained in terms of the tonal consonance of collec-

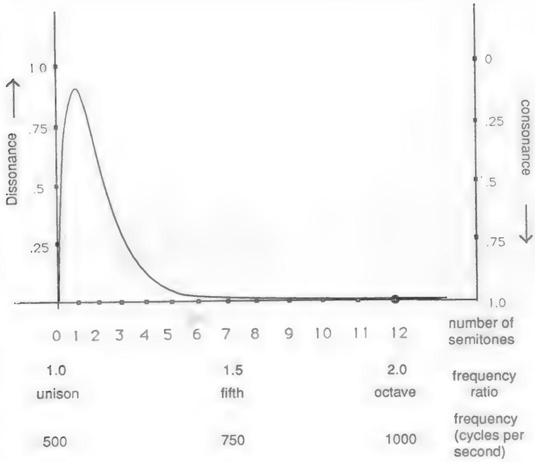


FIGURE 1 (above): Dissonance curve for pure sine waves as a function of frequency difference. The consonance and dissonance scales are arbirary.

FIGURE 2 (right): The standard harmonic timbre used to generate the dissonance curve of figure 3. Amplitudes fall at a rate of 0.88. The frequency axis is normalized so that the root frequency is unity.

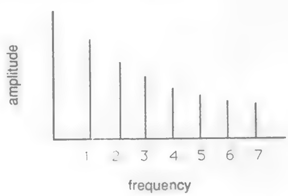


FIGURE 3 (below): Dissonance curve for the timbre of figure 2. The horizontal axis represents frequency difference. Dots mark the location of notes in the standard 12-tone equal-tempered scale. The vertical axis is arbitrary, and all dissonance curves are normalized so that the largest value occurs at unity.

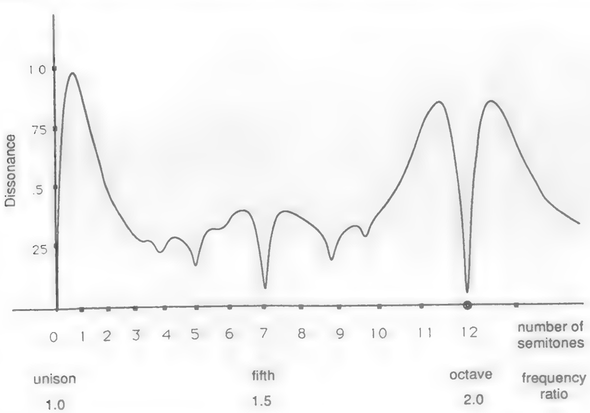


TABLE 1: Location of minima of figure 3, $\beta = \sqrt[12]{2}$

Location of Minima	Nearest 12-tone Scale Step	Nearest Ratio	Interval Name
1.20	$\beta^3 = 1.189$	6:5	Minor 3rd
1.25	$\beta^4 = 1.159$	5:4	Major 3rd
1.33	$\beta^5 = 1.335$	4:3	Perfect 4th
1.40	$\beta^6 = 1.414$	7:5	Augmented 4th
1.50	$\beta^7 = 1.498$	3:2	Perfect 5th
1.67	$\beta^8 = 1.587$	5:3	Major 6th
1.75	$\beta^{10} = 1.782$	7:4	Minor 7th
2.00	$\beta^{12} = 2.000$	2:1	Octave

tions of pure sine waves. Plomp and Levelt note that most traditional musical tones have a spectrum consisting of a root or fundamental frequency, and a series of sine wave partials that occur at integer multiples of the fundamental. Figure 2 depicts one such timbre. If two tones with this timbre are sounded at some interval, the dissonance between the tones can be calculated by adding up all of the dissonances between all pairs of partials. Carrying out this calculation for a range of intervals leads to the dissonance curve. For example, the dissonance curve formed by the timbre of figure 2 is shown in figure 3.

Observe that figure 3 contains major dips at nearly all consonant intervals of the 12 tone equal tempered scale. The most consonant interval is the unison, followed closely by the octave. Next is the fifth, followed by the fourth, the major third, the major sixth, and the minor third. These agree with standard musical usage and experience. Looking at the data more closely (see table 1) shows that the minima do not occur at exactly the scale steps of the 12-tone equal-tempered scale. Rather, they occur at the "nearby" simple ratios 1:1, 2:1, 3:2, 4:3, 5:4, and 5:3 respectively, which are exactly the locations of notes in the "justly intoned" scales (see Wilkinson). Thus an argument based on tonal consonance is consistent with the use of just intonation (scales based on intervals with simple integer ratios), at least for harmonic timbres.

Perhaps the most striking aspect of figure 3 is that many of the scale steps are coincident with local minima of the dissonance curve. Thus the ear perceives intervals which occur at points of local minima in the dissonance curve as relatively consonant. This observation forms the basis of the principle of local consonance:

A timbre and a scale are said to be related *if the timbre generates a dissonance curve whose local minima occur at scale positions.*

This notion of relatedness of scales and timbres suggests two interesting avenues of investigation. Given an arbitrary timbre T (perhaps one whose spectrum does not consist of a standard harmonic series), it is straightforward to draw the dissonance curve generated by T. The local minima of this curve occur at values which are good candidates for notes of a scale, since they are local points of minimum dissonance (i.e. maximum consonance). This might be useful to the experimental musician. Imagine being in the process of creating a new

instrument with an unusual (i.e., non-harmonic) tonal quality. How should the instrument be tuned? To what scale should the finger holes (or frets, or whatever) be tuned? The principle of local consonance answers this question in a concrete way.

Alternatively, given a desired scale (perhaps one which divides the octave into *m* equal pieces, or one which is not based on the octave), there are timbres which will generate a dissonance curve with local minima at precisely the scale degrees. This is useful to musicians and composers who wish to play in nonstandard scales such as 10-tone equal temperament.

As the opening quote indicates, this is not the first time that the relationship between timbre and scale has been explored. J.R. Pierce's brief note [see bibliography for complete references] reported synthesizing a timbre designed specifically to be played in an 8 tone equal tempered scale. Pierce concludes, "... by providing music with tones having accurately specified but nonharmonic partials, the digital computer can release music from the tyranny of 12 tones without throwing consonance overboard." F.H. Slaymaker investigated timbres with stretched (and compressed) partials, and Mathews and Pierce explored their potential musical uses. Recently, Mathews and Pierce examined a scale with steps based on $\sqrt[13]{3}$, rather than the standard $\sqrt[12]{2}$, which is designed to be played with timbres containing only odd partials. Wendy Carlos investigated scales for nonharmonic timbres by overlaying their spectra and searching for intervals in which partials coincide, thus minimizing the beats (or roughness) of the sound. This is similar to the present approach, but we provide a systematic technique that can be used to find scales for a given timbre, or to find timbres for a given scale.

It would be naive to suggest that truly musical properties can be measured as a simple tonal consonance. Even in the realm of harmony (and ignoring musically essential aspects such as melody and rhythm), consonance is not the whole story. Indeed, a harmonic progression that was uniformly consonant would likely be boring. Harmonic interest arises from a complex interplay of dissonance (restlessness) and consonance (rest). Perhaps the most important use of the principle of local consonance is to provide guidelines for exploring new tonalities and tunings.

HOW TO CALCULATE DISSONANCE CURVES

If you're thinking that there must be a lot of calculations necessary to draw dissonance curves, you're right. It's an ideal job for a computer.

Those familiar with BASIC or related computer languages may wish to look at the program appearing at the end of this article. (It is written in Microsoft's version of BASIC.) The program works by encapsulating the Plomp-Levelt consonance curve into a mathematical function that consists of a sum of exponentials. The *i* and *j* loops calculate the dissonance of the timbre at a particular interval *alpha*, and the *alpha* loop runs through all the intervals of interest. The first few lines set up the frequencies and amplitudes of the timbre. The variable *numf* must be equal to the number of frequencies in the timbre. Running the program as is generates the dissonance data of figure 3 for the timbre of figure 2. To change the start and end points of the intervals, use *startint* and *endint*. To make the intervals further apart, increase *inc*. All the dissonance values are stored in the vector *diss*. Don't change *dstar* or any of the variables with numbers.

Fortunately, there are some general patterns in the ways that dissonance curves can look. Let's examine a simple timbre with just two partials. As shown in figure 4, the dissonance curve can have three different contours: if the partials are very close

FIGURE 4: The three possible dissonance curves for timbres with two partials.

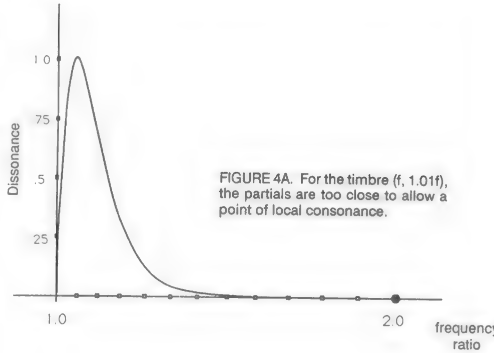


FIGURE 4A. For the timbre (f, 1.01f), the partials are too close to allow a point of local consonance.

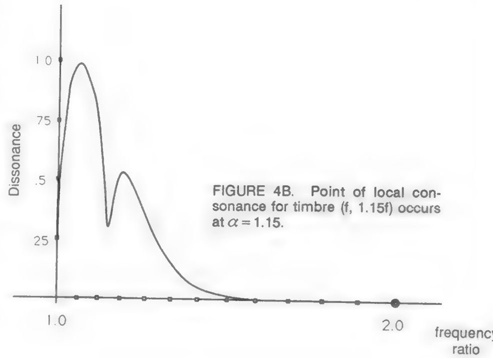


FIGURE 4B. Point of local consonance for timbre (f, 1.15f) occurs at $\alpha = 1.15$.

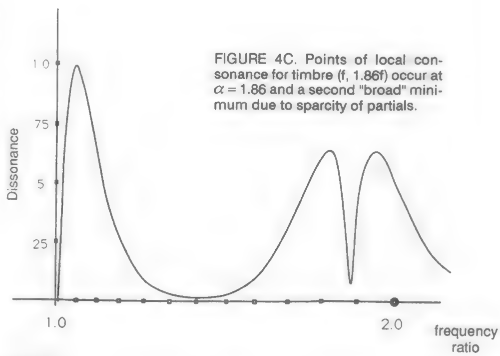


FIGURE 4C. Points of local consonance for timbre (f, 1.86f) occur at $\alpha = 1.86$ and a second "broad" minimum due to sparcity of partials.

together then there are no points of local consonance, if the partials are widely separated then there are two local minima, if they are in between then there is just one. Using the program, you can reproduce these curves (or, of course, generate your own). Set `numf=2` and `freq(1)=500`, `freq(2)=505`, amp(1) = 10, amp(2) = 10. This gives figure 4(a), where the partials are too close to allow a point of local consonance. Setting freq(2) = 1.15*500 shows that the point of local consonance occurs at an interval of 1.15, as in 4(b). Finally, setting freq(2) = 1.86*500 gives 4(c), with two points of local consonance. The steep minimum occurs at an interval of 1.86. Notice that the second minimum is broad, and is a result of the large distance between the partials of the timbre.

You can listen to figure 4 with a synthesizer or tone generator. First, find a tone that is as close to a sine wave as possible. (If using a sample based machine without such a humble waveform, try an organ or flute sample). Assign two tones to each keypress, one at frequency f, and one at a major seventh above f. (A major 7th is an interval of 1.86, just as in 4(c)). Listen to the consonance of the various intervals in this timbre. The first few are very rough. The next few are somewhat aharmonic, but not unpleasant. Then the dissonance rises and plummets quickly, at the interval of 1.86. The octave, at an interval of 2, sounds very dissonant and unoctavelike. For this timbre, the major 7th plays the role normally occupied by the octave, at least in terms of consonance. This is something you can hear for yourself.

PROPERTIES OF DISSONANCE CURVES

Suppose that the timbre T has n partials located at frequencies $(f_1, f_2, \ldots, f_n)$. [To help you keep track, these and other variables used in this article are listed in the box on this page.]

For any given interval α, the dissonance between the timbre T and the timbre αT (with frequencies at $(\alpha f_1, \alpha f_2, \ldots, \alpha f_n)$ can be readily calculated. The dissonance curve generated by T is defined to be a plot of the dissonance between T and αT over all intervals α of interest. Here are some general properties of dissonance curves:

Property (1): Dissonance curves may have up to $2n(n\text{-}1)$ minima.

Property (2): The unison is the global minimum (the lowest possible value of the dissonance curve).

Property (3): As the interval grows very large (as α goes to infinity), the dissonance approaches a value that is no more than the intrinsic dissonance of the timbre itself.

Property (4): Up to half of the local minima occur at intervals α for which $\alpha = f_i/f_j$ where f_i and f_j are arbitrary partials of T. Up to half of the local minima are the broad type of figure 4(c).

The fourth property is particularly interesting because it says that points of local consonance tend to occur at intervals which are simply defined by the partials of the timbre. In figures 4(b) and 4(c), for instance, local minima are found at $\alpha = 1.15$ and $\alpha = 1.86$ respectively, which is the ratio between the two partials. The broad minima tend to vanish for timbres with more than a few partials. Figure 3, for instance, consists exclusively of local minima caused by coinciding partials. Thus, dissonance curves usually have fewer than $2n(n\text{-}1)$ local minima. In figure 3, for instance, there are only 9 local minima within the octave of interest, considerably fewer than the theoretical maximum of 84. It is possible to achieve the bound. For instance, the timbre $(f, 2f, 3f)$ over the range $0 < \alpha < 6$ exhibits all 12 possible minima.

FROM TIMBRE TO SCALE

This section constructs examples of scales appropriate for a variety of timbres, and explains various consonance related phenomena in terms of the principle of local consonance.

Harmonic Timbres

The points of local consonance for the harmonic timbre with partials at $(f, 2f, \ldots, 7f)$ are located at simple integer ratios. The results of the previous section explain this elegantly. Candidate points of local consonance are at intervals α for which $f_i = \alpha f_j$. Since the partials are at integer multiples of f, $\alpha = x/y$ for integers x and y between 1 and 7. The principle of local consonance says that the most appropriate scale tones for harmonic timbres are located at such α, and indeed, all the points of local consonance of figure 3 occur at such values, as tabulated in table 1. In a sense, this provides a physical basis for justly intoned scales. In terms of tonal consonance, the ear is fairly insensitive to small deviations in frequency, and the 12 tone equal tuning can be viewed as an acceptable compromise between the consonance-based desire to play in justly intoned scales and the practicalities of instrument standardization.

Stretched and Compressed Timbres

Slaymaker and Mathews and Pierce have investigated timbres with partials at $f_j = f A^{\log_2 j}$. When $A = 2$, this is simply a harmonic timbre, since $f_j = f\, 2^{\log_2 j} = jf$. When $A < 2$, the frequencies of the timbre are compressed, while when $A > 2$, the partials are stretched. The most striking aspect of compressed and stretched timbres is the lack of a real octave. This can be seen clearly from the dissonance curves, which are plotted in figures 5(a), (b), (c), and (d) for $A = 1.87$, 2.0, 2.1, and 2.2 respectively. In each case, the frequency ratio A plays the role of the octave, which Mathews and Pierce call the *pseudo octave*. Real octaves sound dissonant and unresolved when A is different from 2 while the pseudo octaves are highly consonant. More importantly, each curve has a similar contour. Points of local consonance occur at (or near) the twelve equal steps of the pseudo octaves. "Pseudo-fifths," "pseudo-fourths," and "pseudo-thirds" are readily discernable. This suggests that much of music theory and practice can be transferred to compressed and stretched timbres, when played in compressed and stretched scales.

RECURRING VARIABLES USED IN THIS ARTICLE

The following symbols are used to designate variable quantities in this article:

α (alpha) – An interval, being the ratio of the fundamental frequencies of the two tones that make the interval.

β (beta) – In an equal temperament, the factor by which the frequency of any scale degree is multiplied to get the frequency of the next scale degree.

a – Amplitude

f – Frequency

i and j – Identifying labels given to individual partials within a timbre.

J – "Cost," being the cumulative amount of dissonance for a given timbre over the intervals of a given scale.

m – The number of scale steps within the octave for a given scale.

n – The number of partials within a given timbre.

T – Timbre.

Some additional variables occur locally in the article; they are defined in context at the point of their appearance.

FIGURE 5: Dissonance curves generated by stretched and compressed timbres. Each figure has two horizontal axes. The bottom axis shows the standard 12-tone equal-tempered divisions of the octave (frequency ratio 2:1). The top axis shows twelve equal divisions of the pseudo-octave with a frequuncy ratio of A:1.

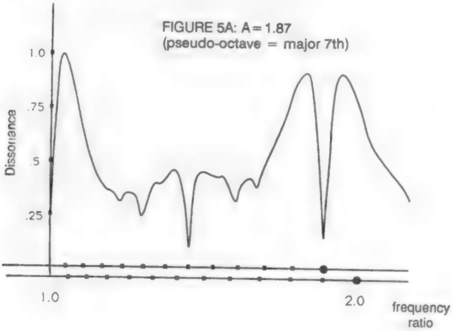


FIGURE 5A: A=1.87
(pseudo-octave = major 7th)

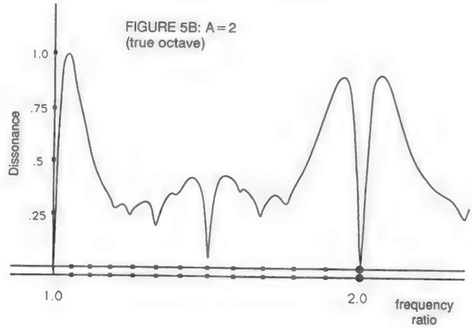


FIGURE 5B: A=2
(true octave)

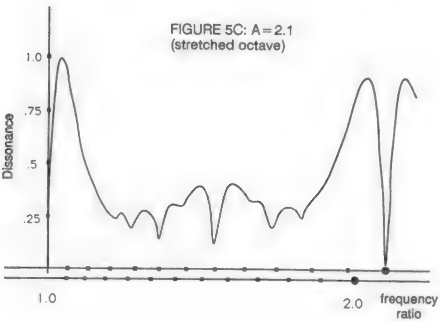


FIGURE 5C: A=2.1
(stretched octave)

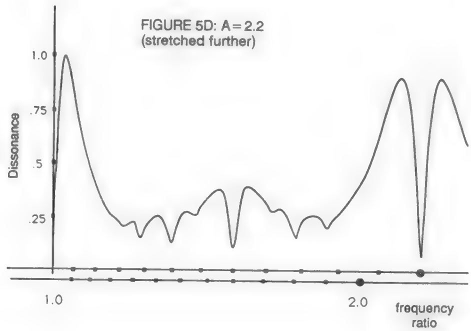


FIGURE 5D: A=2.2
(stretched further)

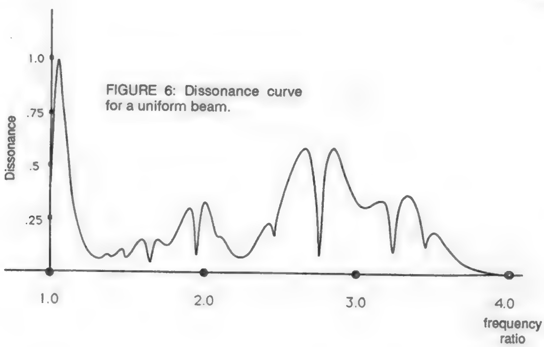


FIGURE 6: Dissonance curve for a uniform beam.

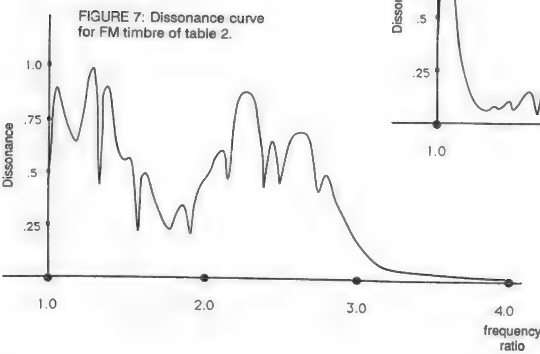


FIGURE 7: Dissonance curve for FM timbre of table 2.

A Tuning for Uniform Beams

It is well known that glockenspiels, marimbas, and other instruments which consist of beams with free ends, have partials which are not harmonically related. The principle of local consonance suggests that there is a natural scale, defined by the timbre of the instrument, in which it will sound most consonant. The first seven frequencies of an ideal beam which is free to vibrate at both ends are given by Fletcher and Rossing as

$(f, 2.758f, 5.406f, 8.936f, 13.35f, 18.645f, 24.82f)$.

Two octaves of the dissonance curve for this timbre are shown in figure 6. The curve has numerous minima which are spaced unevenly at

1, 1.27, 1.33, 1.4, 1.49, 1.65, 1.96, 2.09, 2.25, 2.47, 2.76, 3.05, 3.24, 3.45, and 3.98,

which suggests that this would be the most natural sounding tuning for such an instrument, at least in terms of consonance.

Tuning for FM Timbres

One common method of sound synthesis is frequency modulation (FM) (see Chowning). Noninteger ratios of the carrier and modulating frequencies give nonharmonic timbres that are often used for percussive or bell sounds because they are dissonant when played in traditional 12 tone harmonies. The principle of local consonance suggests that such sounds can be played more harmoniously in scales which are determined by the timbres themselves.

For example, consider a simple FM tone with carrier-to-modulator ratio $c{:}m$ of 1:1.4 and modulating index $I=2$. The frequencies and amplitudes of the resulting timbre are tabulated in table 2, and three octaves of the dissonance curve are plotted in figure 7. The appropriate scale notes for this timbre occur at the local minima of the dissonance curve, which can be read directly from the figure.

FROM SCALE TO TIMBRE

The optimal scale for a given timbre is found simply by locating the local minima of the dissonance curve. The complementary problem of finding an optimal timbre for a given scale is not as simple. There is no single "best" timbre for a given scale. But it is often possible to find "locally best" timbres which can be specified as the solution to a certain optimization problem. For certain classes of scales (such as the m-tone equal tempered scales) the properties of the dissonance curve can be exploited to solve the problem efficiently.

Timbre Selection as an Optimization Problem

Suppose that a set of m scale tones is specified. A naive approach to the problem of timbre selection is to choose a set of n partials $(f_1, f_2, \ldots, f_n)$ and amplitudes $(a_1, a_2, \ldots, a_n)$ to minimize the sum of the dissonances over all the intervals in the scale. Unfortunately, this can lead to "trivial" timbres in two ways. Zero dissonance can be achieved by setting all the amplitudes to zero, or by allowing the partials to have arbitrarily high frequencies (recall property 2). To avoid such trivial solutions, some constraints are necessary:

Constraint 1: Don't allow the amplitudes to change; that is, choose a fixed set of amplitudes before carrying out the operation.

Constraint 2: Force all frequencies to lie in a predetermined region.

The revised (constrained) optimization is then: With the amplitudes fixed, select a set of n frequencies $(f_1, f_2, \ldots, f_n)$ lying in the range of interest so as to minimize the cost

$$J = w_1 \text{ (sum of dissonances over all intervals)} + w_2 \text{ (number of points of local minima)}$$

where the w_1 and w_2 are weighting factors. Minimizing this cost J tends to place the scale steps at local minima as well as to minimize the value of the dissonance curve. Experimentally, weightings of $w_1/w_2 = 1000/1$ seem to be reasonable.

Minimizing the cost J is an n-dimensional optimization problem with a highly complex error surface. Fortunately, such problems can be solved adequately (though not necessarily optimally) using a variety of "random search" methods such as "simulated annealing," (see Kirkpatrick) or the "genetic algorithm" (see Goldberg).

The genetic algorithm (GA) seems to work well. The GA requires that the problem be coded in a finite string called the "gene" and that a "fitness" function be defined. Genes for the timbre selection problem are formed by concatenating binary representations of the f_i. The fitness function of the gene $(f_1, f_2, \ldots, f_n)$ is measured as the value of the cost J above, and timbres are judged "more fit" if the cost J is lower. The GA searches n-dimensional space measuring the fitness of timbres. The most fit are combined (via a "mating" procedure) into "child timbres" for the next generation. As generations pass, the algorithm tends to converge, and the most fit timbre is a good candidate for the minimizer of J. Indeed, the GA tends to return timbres which are well matched to the desired scale in the sense that scale steps tend to occur at points of local consonance and the total dissonance at scale steps is low. For example, when the 12 tone equal tempered scale is specified, the GA converges near harmonic timbres quite often. This is a good indication that the algorithm is functioning and that the free parameters have been chosen sensibly.

Timbres for an Arbitrary Scale

As an example of the application of the genetic algorithm to the timbre selection problem, a desired scale was chosen with scale steps at 1, 1.1875, 1.3125, 1.5, 1.8125, and 2. A set of amplitudes were chosen as 10, 8.8, 7.7, 6.8, 5.9, 5.2, 4.6, 4.0, and the GA was allowed to search for the most fit timbre. The frequencies were coded as 8 bit binary numbers with 4 bits for the integer part and 4 bits for the fractional part. The best three timbres out of 10 trial runs of the algorithm were

$(f, 1.8f, 4.9f, 14f, 9.87f, 14.81f, 6.4f, 12.9f)$

$(f, 1.5f, 3.3f, 10.3f, 7.8f, 7.09f, 3.52f, 3.87f)$

$(f, 2.39f, 9.9275f, 7.56f, 11.4f, 4.99f, 6.37f, 10.6f)$

The dissonance curve of the best timbre is shown in figure 8.

TABLE 2: Partials for the FM timbre with c:m of 1:1.14 and modulating index I=2

	Frequency	Amplitude
c-m	0.4	.57
c	1.0	.22
c-2m	1.8	.35
c+m	2.4	.57
c-3m	3.2	.13
c+2m	3.8	.35
c-4m	4.6	.03
c+3m	5.2	.13
C+4m	6.6	.03

FIGURE 8: Dissonance curve for the scale with steps at 1, 1.18, 1.31, 1.5, 1.81, and 2.

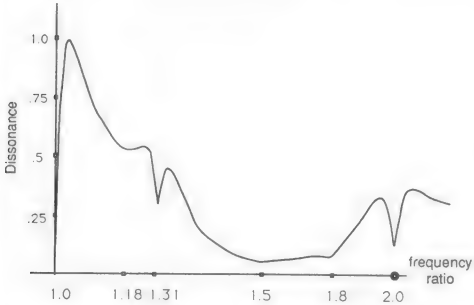
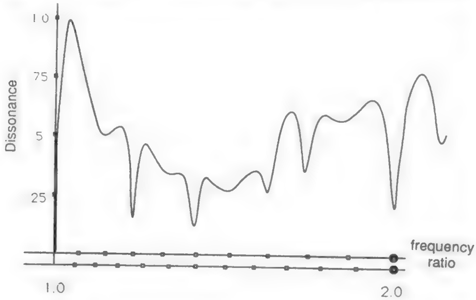


FIGURE 9: Timbre designed to be played in 10-tone equal-tempered scale. Note that points of local consonance coincide with the 10-tone scale (top axis), but not with the 12-tone equal-tempered scale steps (bottom axis).



Clearly, these timbres are related to the specified scale, since points of local consonance occur precisely at the scale steps.

Timbres for Equal Temperaments

For certain scales, such as the m-tone equal tempered scales, properties of the dissonance curve can be exploited to quickly and easily design timbres, thus bypassing the need to run an optimization program.

Recall that the ratio between successive scale steps in 12 tone equal temperament is the twelfth root of 2 (about 1.0595), in symbols $\sqrt[12]{2}$. Similarly, m-tone equal temperament has a ratio of $\beta = \sqrt[m]{2}$ between successive scale steps. Consider timbres for which successive partials are ratios of powers of β. Each partial of such a timbre, when transposed into the same octave as the fundamental, lies on a note of the scale. Such a timbre is said to be *induced* by the m-tone equal tempered scale. For example, harmonic timbres are induced timbres for the justly intoned scale.

Induced timbres are good candidate solutions to the optimization problem. Recall from property 4 that points of local consonance tend to be located at intervals α for which $f_i = \alpha f_j$ where f_i and f_j are partials of the timbre T. Since the ratio between any pair of partials in an induced timbre is β^k for some integer k, the dissonance curve will tend to have points of local consonance at such ratios: these ratios occur precisely at steps of the scale. Such timbres tend to minimize the cost J.

This insight can be exploited in two ways. First, it can be used to reduce the search space of the optimization routine. Instead of searching over all frequencies in a bounded region, the search need only be done over induced timbres. More straightforwardly, the timbre selection problem for equal tempered scales can be solved by careful choice of induced timbres.

As an example, consider the problem of designing timbres to be played in 10-tone equal temperament. 10-tone is often considered one of the worst temperaments for harmonic music, since the steps of the ten tone scale are distinct from the (small) integer ratios, implying that harmonic timbres are very dissonant. The principle of local consonance asserts that these intervals will become more consonant if played with correctly designed timbres. Here are three timbres induced by the 10-tone equal tempered scale. Let $\beta = \sqrt[10]{2}$.

$$(f, \beta^{10} f, \beta^{17} f, \beta^{20} f, \beta^{25} f, \beta^{28} f, \beta^{30} f)$$
$$(f, \beta^{7} f, \beta^{16} f, \beta^{21} f, \beta^{24} f, \beta^{28} f, \beta^{37} f)$$
$$(f, \beta^{7} f, \beta^{13} f, \beta^{17} f, \beta^{23} f, \beta^{28} f, \beta^{30} f)$$

The dissonance curve of the first timbre is shown in figure 9. All of these sound quite nice when played on a 10-tone equal tempered scale. Not surprisingly, the same tones sound quite ugly when played in a standard 12 tone scale.

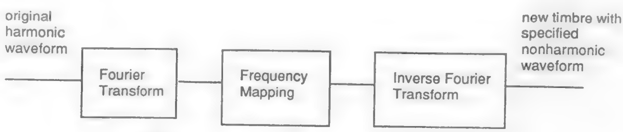
Analogous arguments suggest that the consonance of 12 tone equal tempered tuning can be maximized by moving the partials away from the harmonic series to a series based on $\beta = \sqrt[12]{2}$.

NEW INSTRUMENTS, ANYONE?

Any arbitrary timbre (set of frequencies and amplitudes) can be realized with the aid of a computer. Is it always possible to design acoustic instruments that will have a given timbre? How about brasses? Fletcher and Rossing proclaim that "If the flaring part of the horn extends over a reasonable fraction of the total length, for example around one third, then there is still enough geometrical flexibility to allow the frequencies of all modes to be adjusted to essentially any value desired." With stringed instruments, the trick is to find a variable thickness and/or variable stiffness string that will vibrate with partials at the desired frequencies. The partials of a drumhead can be tuned by weighting or layering sections of the drumhead. The partials of reed instruments can be manipulated by the contour of the bore as well as the shape and size of the tone holes. Bells can be tuned by changing the shape and thickness of the walls. Exactly how to engineer acoustic instruments with specified timbres is an interesting issue.

Even if it is not always possible to make acoustic instruments with an arbitrarily specified timbre, it is possible to synthesize the timbres. One approach is diagrammed in figure 10, where a

FIGURE 10 (right): A resynthesis approach to the generation of nonharmonic timbres



harmonic waveform (which may be a sample of an acoustic instrument) is transformed into its constituent frequencies. The frequencies are changed in a systematic way that maps the partials into the specified timbre, and then transformed back into a useable waveform. The result would be a nonharmonic timbre with much of the character of the original instrument.

The principle of local consonance shows how to imagine a number of differently tuned orchestras, digital or acoustic, each with instruments designed with a particular timbre and played in the related tuning. How about a band of instruments tuned to stretched or compressed tunings? An orchestra optimized for seven or ten tone equal temperaments? A wind instrument with the timbre of a drum? A trumpet with the harmonic structure of a steel beam? The consonance curve shows how to properly tune the instrument. Using a computer to generate the timbres gives the ability to audition the design before building, saving time in the design and specification of nontraditional instruments.

CONCLUSIONS

This paper developed the principle of local consonance which shows how to relate timbres and tunings. Two complementary computational techniques were proposed: a way to find consonant scales given a specified timbre, and a way to find consonant timbres given a specified scale. One implication is that the musical notion of consonance of intervals such as the octave and fifth can be viewed as a result of the timbre of the instruments we typically use. The justly intoned scales can similarly be viewed as a consequence of the harmonic timbres of musical instruments.

The advent of inexpensive musical synthesizers capable of realizing arbitrary sounds allows exploration of nonharmonic acoustic spaces. The principle of local consonance provides guidelines on how to sensibly relate tuning and timbre. More ambitiously, it is easy to imagine new nonharmonic instruments capable of playing consonant music. The computational techniques of this paper allow specification of timbres and tunings for such instruments.

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The author would like to thank Tom Staley for numerous discussions on tuning, timbre, and tonality. Don Hall, Bart Hopkin, and Bill Strong were quite helpful in improving various versions of this work.

Bill Sethares masquerades as a professor of electrical engineering at the University of Wisconsin. He has been spending so much time listening to nonharmonic and microtonal music that just about everything has begun to sound strange.

MICROSOFT *BASIC* PROGRAM FOR CALCULATING DISSONANCE CURVES

```
DIM freq(10),amp(10),g(10),diss(1500)

' Here are the variables you must set:
' numf=number of frequencies in timbre f
' freq(i) = frequency value of ith partial
' amp(i) = amplitude of ith partial

numf=7
freq(1)=500: freq(2)=1000: freq(3)=1500: freq(4)=2000
freq(5)=2500: freq(6)=3000: freq(7)=3500
amp(1)=10: amp(2)=8.8: amp(3)=7.7: amp(4)=6.8
amp(5)=6: amp(6)=5.3: amp(7)=4.6

' loop through all intervals from startint to endint

dstar=.24: sl=.0207: s2=18.96: cl=5.0: c2=-5.0
al=-3.51: a2=-5.75: index=-1
PRINT "Interval          Dissonance"
startint=1: endint=2.2: inc=.01
FOR alpha=startint TO endint STEP inc
    index=index+1: d=0
    FOR k=1 TO numf
        g(k)=alpha*freq(k)
    NEXTi
    ' calculate dissonance between f and alpha*f
    FOR i=1 TO numf
        FOR j=1 TO numf
            IF amp(i)<amp(j) THEN lij=amp(i) ELSE lij=amp(j)
            IF g(j)<freq(i) THEN fmin=g(j) ELSE fmin=freq(i)
            s=dstar/(sl*fmin+s2): fdif=ABS(g(j)-freq(i))
            arg1=a1*s*fdif: arg2=a2*s*fdif
            IF arg1<-88 THEN exp1=0 ELSE exp1=EXP(arg1)
            IF arg2<-88 THEN exp2=0 ELSE exp2=EXP(arg2)
            dnew=lij*(cl*exp1+c2*exp2): d=d+dnew
        NEXTj
    NEXTi
    diss(index)=d
    PRINT alpha, d
NEXT alpha
STOP
```

RECORDINGS REVIEWS

By Sasha Bogdanowitsch & René van Peer

ARTHEA: **PASSAGES**

On CD from Wergo Schallplatten, GmbH Mainz, West Germany

Arthea's *Passages* is a wonderful instrumental flight of fancy that takes inspiration from many traditional world cultures, such as Persia, the Orient, India, Indonesia, Africa, and Australia. The group consists of three French composer/performer/instrument builders: G. Alloro, F. Bourlier, and P. Jauneaud. Each makes and plays a variety of instruments, in an effort to form a syntheisis of the traditional instrumental families of the world.

The eight pieces on the disc take the listener through a variety of sonic jungles. The group members admit in their linear notes that they have forsaken all notated scores and musical systems. This doesn't seem to bring down the music's quality and compositional interest at all. They offer new sounds and new textures with the ear alone as their guide.

In "Surya" one finds the Indonesian slendro pentatonic tuning explored with the fantastical *contre-bass nei* (a giant, contemporary metal keyed version of the middle eastem vertical reed flute), the *percutube* (a bamboo thongaphone) and the *xylo-metalo-phone* (a cross between a Balinese gangsa and western xylophone). Two more Eastern pentatonic excursions in the pieces, "Overtones" and "Pentatonic", highlight the Indianesque *tampura* (a concave zither with twelve strings that recreates the characteristic buzzing, harmonic sound of many Indian string instruments) and the *altar* a (a cross between the bodies of the North Indian rudra vina and sitar with moveable scalloped frets and giant gourds for resonance), along with the Persianesque *tar-bass* and the Japanese-influenced *kotar*.

Though some of the pieces, like "Ancestral Now" and "Soufles" might easily fall into the category of arhythmic, self indulgent noodlings in sound with slide and bird whistles, odd percussion, vocalizing, etc., all in all this beautifully recorded disc of orginal music and instruments by three very innovative musicians is quite worth the listen and quest to find it (it's six years old and from a sometimes hard-to- find German label). To quote the band, " 'departure' and 'adventure' were necessary in the past, today 'return' is required."

—*SB*

THE 25-YEAR RETROSPECTIVE CONCERT OF THE MUSIC OF JOHN CAGE (1958)

Three LP-set in box with program notes, essays including "The Future of Music: Credo," and score excerpts; available from George Avakian, 795 West 254th Street, Riverdale, NY 10471

New music has its own history. There has been development; ideas have been put forward verbally and musically, to be scrutinized, enjoyed, disputed. Much of what it always has been about, is the notion of immediacy, the experience of an event that is unique in time. It is about getting submerged in a current, flowing along with it, making it by being a part of it. Maybe that is why historical documentation is rare.

One extraordinary document is the recording of the *25-year Retrospective Concert of the Music of John Cage*, dating from 1958. A number of copies of this box with three LPs, unavailable for quite some years, recently came to light in a storage place where they had possibly been standing forgotten since the day they were pressed. They were returned to the original producer, George Avakian, who sends them out through mail order.

This issue represents different historical perspectives. In a good quality stereo pressing it is the recreation before your very ears of an entire concert of Cage's music staged 35 years ago. It is a selection of compositions that highlights especially one aspect of his work: his investigations into sound. This is evident from the ten pieces themselves; the included program notes and essays further examine the theme. The recording shows Cage's sensitivity in this beyond all doubt. There is a lot of variety in his treatment of timbre, of combining instruments with each other -- now through contrast, now through blending.

In *Construction in Metal* he seems to pull up the anchor from the tonal (and thus: harmonic and melodic) system of academic music. It's a beautiful exercise in timbres radiating from metal. *Imaginary Landscape 1* involves "variable and constant frequency records" on tape plus cymbal and piano. The soft hum from the equipment serves as a soil from which grows a dispassionate wailing, a repetitious muted staccato phrase of just a few tones, and the lush rustle and crash of the cymbal. *The Wonderful Widow of 18 Springs* pairs a simple melody of half sung half intoned shifts in sequence and emphasis in three notes, with hollow knocks and raps on various parts of a closed grand piano. This delicate piece contrasts the duration of tones from a typically undramatic, and yet gentle, voice with dry taps that are enlivened by the faint shadow of reverberation inside the instrument.

More delicacy is to be found in the central piece of the program, *Sonatas and Interludes* for prepared piano, dedicated to Maro Ajemian, the musician playing it here. This is another exploration into timbral possibilities, now within this buttress of Western music. Just like timbre as such is the result of piled up harmonics, the variable sound of the piano throughout this large scale composition is the result of layering ever-changing timbres.

As Cage asserts in one of the essays, sound is made up of pitch, loudness, timbre and duration. This recording is particularly successful in that it gives evidence of how he managed to distill these aspects into very pure and absolute music; also in that it allows the listener to focus on them, not in isolation but neither in their conventional state of confusion.

Not only does this make listening thoroughly enjoyable, it seems to say different things every time you hear it. Coming with Cage's essay "The Future of Music: Credo," the recording provides healthy food for thought. One quotation sums it all up for me: "One may give up the desire to control sound, clear his mind of music, and set about discovering means to let sounds be themselves, rather than vehicles for man-made theories or expressions of human sentiments ... Sounds, when allowed to be themselves, do not require that those who hear them, do so unfeelingly."

This is not Cage the icon, this is Cage the man. I hesitate to call the package a monument. Elevation can do a person and a remembrance great harm. This true-to-life document, however, can make an uninhibited listener love John Cage and what he set out to do. Therefore, to my judgment, it is priceless. It is vital matter for anyone who takes genuine interest in the nature, the essence, of music and sound — and communication.

—*RvP*

THE CERAMIC ENSEMBLE: **SOUNDING CLAY**

On cassette from R.T. Music, 4111 Mt. Baldy Rd., Claremont, CA 91711

"Sounding Clay" is the dynamic debut of Brain Ransom's Ceramic Ensemble. Brain is an accomplished ceramicist and teacher whose works truly live up to the meaning of the word *sound sculpture*.

As beautiful sonically as visually (I recently had the pleasure of seeing some of the instruments at the Hollywood Bowl Museum in Los Angeles), the Ceramic Ensemble's instruments cover a wide range of categories. From ocarinas, pipes, and flutes, similar in sound and shape to the creations of Susan Rawcliffe and Sharon Rowell, to the subtle sounds of a clay kora and ceramic bells, to the uncanny ceramic "sax-o-snake" and flugelhorn, the compositions of Brian Ransom, Norma Tanega, and Ernesto Salcedo take influences from a wide band of musical tastes. Primal, earthy sounds, medieval music, ambient music and contemporary jazz seem to be the prevailing mixtures explored.

Although the Ceramic Ensemble shows its prowess in the performance of various jazz and world music styles (mostly suggesting Africa and South America), the pieces that really live up to the promise of the instruments are the more original pieces that don't seem to take influences from pre-existing styles. From the atmospheric twitterings of birds and jungle sounds, the Native-Americanesque flute explorations and the African percussion jams of the "River Suite", to the jazz stylings of "On the Beach" and "Salsafied," *Sounding Clay* provides some good avenues for the clay instruments (as well as some synthesizers) to shine. But it is in the works like "Whistle Stop", which utilizes the instrument called Nest of Hooters, and "Fellini", a work that goes far in crossing over jazz boundaries with the sax-o-snake, and "Solstice", with its microtonal textures, that the instruments are most free to be themselves. These pieces give birth to exquisite sounds without holding on to the burden of *musics* having too much cultural baggage, and popular musical styles that already have preconceived instrumental combinations ascribed to them.

—SB

WILLIAM EATON: **WISDOM TREE**

Canyon Records Productions, 4143 N. 16th St., Phoenix, Arizona 85016

From Tempe Arizona, William Eaton is a stringed instrument builder as well as a guitarist, composer, prolific recording artist, and instructor and administrator at the Roberto Venn School of Lutherie.

Reflecting his love of ancient instruments, the musics and myths of the world, and nature's creations, the instruments on Eaton's CD "Wisdom Tree" take on a variety of unique designs. Some of the instruments used on this recording include the "Koto Harp Guitar" (made of curly birch, cedar, elk antler and nylon strings), the Victorian-armoire-inspired "O'ele'n Strings" (made of cedar, walnut and ebony and invoking sounds similar to the Persian tanbur and the Indian sitar), and the 16-stringed "Lyre" (made of maple and based upon the design of the Greek instrument of the same name).

"Wisdom Tree" is an excellent musical display of Eaton's beautiful instruments. Though similar in content to his past recordings, it differs by the extensive use of Edgar Meyer's bass and the absence of R. Carlos Nakai's flutes, making room for the contributions of other instruments, like synthesizes, violin, gourd water drums, electric guitar and flutes that help emphasize a new side to Eaton's music. The pieces range from soft, meditative pieces to bright, folk-like tunes, to drifting, textural pieces seemingly invoking the spirit of the land, its vast reaches and inhabitants. Although many of the pieces lack intriguing rhythmic content, stylistic variety, and sometimes just plain compositional interest, Eaton succeeds in the creation of a true music of Arizona, aided by the his brilliant "natural" instruments and the music they give birth to.

—SB

ELLEN FULLMAN: **BODY MUSIC**

On CD from Experimental Intermedia Foundation,
224 Centre Street, New York, NY 10013

Some four or five years after Het Apollohuis brought out Ellen Fullman's LP *The Long String Instrument* I heard her perform on strings stretched along the length of a vaulted former factory hall. Though reverberation made the sound come out excellently, the concert gave me a rather uneasy feeling -- as if she had reached the end of a line and would now start to only repeat herself. I'm glad to say that this new CD proves me wrong.

She has gone into the instrument and its sonic possibilities; she has invited others to play with her. Having developed and refined techniques of composition for the instrument, she can draw paradoxical beauty from it. The pieces sound simple and complex at the same time. Because the music mostly consists of sustained notes, fast and intricate melodies don't occur. The versatility of the strings lies in the fact that they can be made to speak with so many voices. Overtones are abundant -- in the foreground they form soaring lines, in the background they constitute rich timbres that hover and pulsate in the air. These may range from a sonorous ring to delicate harmonium-like chords. It is a bit of a pity, though, that her vocabulary doesn't hold some edge to balance the smoothness.

Apart from the experience of glorious sound well captured, this CD has two remarkable bonuses: a wonderfully transparent score of "22 Songs," which features most of the recorded pieces, and a diagram of Harry Partch's odd number relationships from 1 to 11. The latter looks like the schematic representation of a carbohydrate molecule or crystal of considerable complexity. Once caught I can't take my eyes from it. I simply have to follow all the lines, and trace the inherent connections. Music is magnetism, that's for sure.

—RvP

MICHAEL HARRISON: **FROM ANCIENT WORLDS**

On CD from New Albion Records, Inc.,
584 Castro #515, San Francisco, CA. 94114

From Ancient Wolds consists of a large just intonation harmonic piano work by young composer, Michael Harrison, that continues in the same vein that La Monte Young has brought us via *The Well-Tuned Piano* and that Terry Riley has given birth to in *The Harp of New Albion*. And indeed Harrison has studied with them both, as well as with the North Indian vocalist, Pandit Pran Nath, of whom both Riley and Young have become devout disciples. The effects of these teachers had led Harrison to tune his piano in just intonation, but he soon discovered the small intonational adjustments called for when changing keys. Several years later, after modifying a seven-foot Schimmel grand piano, Harrison came up with the "Harmonic Piano", able to modulate to multiple key centers at the press of a pedal, all in just intonation. In using only single strings, instead of the usual three unison strings, the Harmonic Piano can play 24 notes per octave, encompassing Pythagorean intervals (intervals factorable only by the numbers 2 and 3), Semptimal intervals (intervals factorable by 7), and Perfect, Alternate, and Simple Ratios.

Michael Harrison's music journeys far and wide in his hour long piece that covers three movements, "Quest for the Rose", "Garden of Avalon", and "Land of the Rose". Harrison explains, "Song of the rose, representing the soul, is the central theme of the work, and is presented in the style of a chorale. Various motifs, cadences, and harmonic relationships from it are echoed in other parts of the work as well, depicting the soul's return in different guises as it travels through the imaginary landscapes of the various sections." 'Echoed in other parts' is definitely the case here, as seen and heard throughout the piece. Sections like "Bells," "Song of the Rose," and "Volcano" explore musical textures from spacious resonant ringing chords, to new age and romantic pianistic textures, to relentless, thunderous outpourings. They occur several times throughout, bringing form and recognition for some, but boredom and conservatism for others.

In constrast, there are unique pieces that take full advantage of the Harmonic Piano's potential. "Aeolian Harp" is one in which the harp-like timbres of the new instrument are explored fully. "Magic Rain" is another, where the seeming humming of etheral voices gives rise to bell and gamelan textures in timbre and mode. Although the influences of his mentors, Young and Riley, are present, especially in the jazz- oriented, rolling bass of "Quest for the Rose" and the poundings of "Mystic Lyre," Michael Harrison is very able in presenting new sounds and compositions that use his instrument, and the still relatively unused tunings of just intonation, to great potential.

—SB

TOM JOHNSON: **MUSIC FOR 88**

On CD from Experimental Intermedia Foundation,
224 Centre Street, New York, NY 10013

The current, ever stronger, focus on numbers tends to marginalize content. It causes mediocre, mind-numbing films and music to be made with huge budgets and consumed by tremendous amounts of people. In the same vein the work done with numbers is restricted to profitable aims, the results are predictable. It takes a great artist to make numbers yield surprise as a result. I consider composer Tom Johnson to be of that magnitude. He is as much a counting-master as he is a puppetmaster. Numbers protrude and dangle from his finger-tips. On *Music for 88* (a reference to the number of keys on a piano) there are all kinds of interaction between Johnson, the numbers and the keyboard that are crystal-clear and miraculous at the same time -- on the keys of Johnson's piano calculations and permutations turn into music. *Musique discrète*, or *numérique* (used in French to denominate digital recordings), might be apt labels for it. It is gentle, but persuasive. What is more, even though in sound his work stands diametrically opposite to Gordon Monahan's *This Piano Thing*(reviewed in EMI, vol VIII #4), his approach to the instrument is likewise radical and new.

—RvP

MUSIC FOR HOMEMADE INSTRUMENTS: **A DECADE OF DEBRIS**

On cassette from MFHI, 262 the Bowery, New York, NY 10012

Surprisingly MFHI comes from New York. Somehow this collective of composers around Skip La Plante radiates a West Coast aroma. EMI's Vol. IV #1 featured an account of their activities in compiling a collection of self-built instruments. They don't just make their instruments, they're proud of actually finding them: most of them are fashioned from discarded material of our consumer's society. A third-world approach in what is still considered to be the cultural hub of the planet (even though there is no saying how appropriate this reputation is at present). Should one take this as a metaphor for the true state of the art, or for the country as a whole, the Western hemisphere maybe? Is it the environment question, raised by musicians?

As the title suggests this tape spans ten years of MFHI's life, breathing the same infectious pleasure as La Plante's article. Each of the members has contributed a piece, ensuring a charming diversity. There are bits of microtonal blues, mews, gamelan, canbanging, snappy ditties, a reference to Aboriginals' Dreamings, a rather explicit anti-sexist text. All quite buoyant and irreverent: in some pieces and instruments the tunings are fixed, in others they certainly are not. It sounds like no problem at all.

—RvP

COLIN OFFORD: **PACIFIC SOUND**

On CD from Move Records, Box 266, Carlton South, Victoria 3053 Australia

Colin Offord is an instrument builder, sound sculptor, performer and visual artist who hails from Sydney, Australia. Colin's speciality is his extraordinary giant mouth bows and a variety of wind instruments, all of which he builds himself. *Pacific Sound* is a beautifully recorded CD that is a wonderful outlet for Colin's music and world-inspired instruments.

The recording is basically divided into four sections: live duets, solo performance on a single sound sculpture, dense multi-tracked pieces, and a lengthy trio piece. The sound sculpture debut is with the Earth Harp, which is made from piano wire and forked branches, and has three holes in the ground covered with plywood and tin sheets that act as resonators. With the aid of musician Tony Lewis, the instrument is converted to a giant mouth bow, using tin cans, hubcaps, and chinese cymbals, and a wind-up gramophone diaphram. It is played with fingers, sticks and stones, and bows.

Live duets with the rigorous and smooth melodies of tin whistles, windpipes and the Great Island Mouthbow are contrasted with evocative multi-layered pieces under the title of "Pacifica Suite". In the three pieces that fit under this title, the listener finds the percussion of moonbells, pressure gongs, thunder dishes, bamboo log drums, and the leg logo. An assortment of wind instruments ebb and flow amongst the interweavings of the percussion. Among them are the moanings and yearnings of conch shells; bass, alto, and soprano windpipes (marvelous hocketting when played percussively); and the high-pitched callings of the Wedge-Tail Eagle Feather Flute and the Lyrebird Flute. These pieces definitely invoke the textures intended by Colin as conveyed in his liner notes, where he describes them as "a musical portrait of an environmentally sound, peacefully co-habited PACIFIC." Musicians Celine Danegan, Tony Lewis, Mic Conway, and Lenny Paul join Colin in performing the suite.

The last section of the CD is devoted to a three movement work called "Riding on the Ring." It highlights the Australasian flute, a transverse flute with a silver flute body and a bamboo headjoint, along with the shakuhachi of Pepe Danza and the Raindrum of Celine Danegan. The timbres are really dazzling together but harmonically the two flutes just float from one mood to another without any real progression; sometimes tonal, sometimes atonal.

All in all, *Pacific Sound* is a thorough demonstration of the wide ranging music and "pacific" instruments of Colin Offord. **Rolling Stone** had this to say: "...should establish Offord as one of the world's most lyrical & imaginative avante-garde musicians – Stockhausen meets World Music – a cultural clash which is different, daring and never uninteresting."

—SB

JIM O'ROURKE: **DISENGAGE**

PROBE: **ILLUSION OF SAFETY**

On CD from Staalplaat, PO Box 83296, Portland, OR 97283

JIM O'ROURKE: **REMOVE THE NEED**

On CD from Cargo Records, 3058 N. Clybourn, Chicago, IL 60618

The strict separation between science and magic as regards their public appreciation is fairly recent. One can even have doubts if this rift exists in reality or whether people only maintain their adherence to it for fear of being considered backward, or superstitious. In days of yore any pursuit of extraordinary knowledge was called alchemy.

Jim O'Rourke may be called an alchemist of music. In concerts he stoops over his guitar, which is lying on a table. With immense concentration he performs minute actions on the instrument, as if he were examining and dissecting a rare and wonderful specimen under a microscope. In a way he is -- the slightest of moves may abruptly alter the entire sound image. He can wander around in this self-created aural world endlessly, luring his breathless audience along vagaries through undreamt-of scenery. Drones form the ground you're walking on, details of the environment are often only dimly discernible, they just catch your attention and then recede into the veils again.

There is a connection between magicians and rodents. In O'Rourke's case the keyword is "prolific." These three CDs are only part of what he brought out over the last year. Each covers a somewhat different segment of the area this musician has under scrutiny. "Remove the Need" contains excerpts from concerts in Chicago and Zurich. The pieces were played and recorded without any more processing than the use of reverb. "Disengage" consists of two studio pieces on which other musicians make their appearance; at times the music blends in with sounds such as splashing water and what seems to be a recording from his front lawn, birds and cars and all. "Probe" is a project by O'Rourke with Dan Burke. It's an hour-long collage of sound recordings of unknown origin mostly, alternated with stretched out chords from what may be synthesizer or keyboard, but could easily be something totally different, nimbly shaped to sound familiar. Deep rumbling, high vibrant piping, a thudding pulse -- flowing into a garage band and a vacuum cleaner, and eventually the manipulation of pieces of wood. End of part one. Soft, soothing drones will lull the listener into a state of benign drowsiness from which he finds himself roused by outbreaks of dog-yelp or the buzz and clank of heavy-duty manufacture.

O'Rourke does not include information about methods and ingredients. Like exotic food his dishes are worth trying and savoring without such knowledge. One has to take the time, one's senses should not be conditioned too strictly. A person of adventurous and curious nature will find a wealth of stimulating surprise and profound enchantment.

—RvP

OSKAR SALA: **MY FASCINATING INSTRUMENT – MIXTURTRAUTONIUM**

On CD from Erdenklang, c/o Ulrich Rützel, In der Habbecke 16-18, 59889 Eslohe, Germany

"Oskar Sala and Alfred Hitchcock working at the sound effects of the movie *The Birds*," reads a caption under a picture where the latter manifest such an awkward placement of his hand on the keyboard of the MixturTrautonium (rather like a child trying out a piano, fingers spread out wide) that whatever he was doing must have been to satisfy the wishes of the photographer. The clumsiness chronicled by posed-for photographs is of all times and places.

This gem can be admired in the booklet of a CD dedicated to the offspring of one of the early electronic instruments, the Trautonium, developed by the German engineer Friedrich Trautwein in the late '20s. The text gives a concise history and (very basically) the principles of the instrument and its successors. For a more detailed account we should turn to Sala, who has made the further development and the promotion of the Trautonium his life-work, or to the historian of 20th century instruments, Hugh Davies.

The CD contains compositions by Oskar Sala, most of them quite conventional apart from the amazing sound effects. This is keyboard music, no doubt about that. But you'll also find unusual sound coloring, bending of pitch and timbre, microtonal intervals, spacey percussion. It seems that Sala has produced over 300 film music works. Doesn't come as a surprise. Captain Nemo pressing and hammering his extraordinary moods onto a keyboard while a giant nautilus is trying to mate its mechanical namesake.

—RvP

Recordings for review may be sent to EMI at PO Box 784, Nicasio CA 94946, or directly to the reviewers: René van Peer, Bachlaan 786, 5011 BS, Tilburg, Holland; Tom Nunn, 3016 25th St., San Francisco, CA 94110, USA; or Sasha Bogdanowitsch, 460 Canal St. #9, San Rafael CA 94901.

BOOK REVIEWS *by Sasha Bogdanowitsch*

THE MILLS COLLEGE GAMELAN: SI DARIUS AND SI MADELEINE

Text and Drawings by Will Ditrich

Distributed by the American Gamelan Institute, Box A-36, Hanover NH 03755 USA

William Colvig and Lou Harrison have been involved in the construction of Indonesian-gamelan-inspired instruments for quite some time now. Many of Harrison's pieces, such as"Homage to Pacifica", "Bubaran Robert", and "Gending Alexander", show the instruments of the Gamelan Si Betty and the Mills College Gamelan in prolific use.

This fine notebook, *The Mills College Gamelan: Si Darius and Si Madeleine,* with text and illustrations by Will Ditrich, documents the design and construction of the gamelan created by Lou Harrison and William Colvig at Mills College in 1981. It serves as an excellent, practical, easy-to-understand guide to building Colvig and Harrison's "American" versions of the diverse gamelan instruments. The clear diagrams, detailed descriptions, and complete dimensions make it seem simple for an enthusiast to start at once constructing his/her own "bonang" of bossed plates, or "gender" of aluminum cans and plywood, or "suling" of PVC pipe.

The only problems that arise are the failure in many cases to specify the materials to be used, and the absence of a much-needed comparison between the instruments shown here and their Indonesian antecedents. Where the materials are indicated, the reader discovers that there is quite a difference between Colvig and Harrison's choices and the Indonesian usages. Indonesian makers traditionally use materials, like bamboo and bronze, that are available within their environment and suited to local technologies. Colvig and Harrison, as well as other makers in the U.S., have shown that the materials around our environment, such as iron, aluminum, PVC plumbing pipe, and brass can be used in the creation of gamelan-like instruments. Harrison comments on some of the differences: "...an iron gong is like painting with oils; you can make changes after you're finished. But a bronze gong is like water colors; you can't change it once it's finished."

Colvig and Harrison's instruments differ from their Javanese counterparts in form as well as material, with instruments such as the gong suwuran, kempul, kenong, and bonang taking on drastically different shapes. For instance, there are no constructions here of nipple shape in bronze, but the gongs and related instruments are rather converted to resonated metallophones, suspended struck metal plates, and bossed aluminum plates. On the other hand, the suling, saron, demung, gambang, slentem, and kendang are far more traditional than the rest.

Readers get an added bonus too, for the notebook also contains a special chapter on tuning. It describes how the Mills Gamelan was specifically tuned to nature's overtone series (just intonation) and the subtleties in the Indonesian slendro (5-tone) and pelog (7-tone) tunings. The last part also includes an informative section on building your own monochord and tracking modes on it, as well as a thorough chapter on gong technology, tracing traditional Indonesian gong making to the not-so-orthodox experiments of Harrison and Colvig.

All in all, despite its very tiny blemishes, "The Mills College Gamelan: Si Darius & Si Madeleine" is a superb notebook for the documentation and creation of an "American Gamelan".

THE OXFORD COMPANION TO MUSICAL INSTRUMENTS

By Anthony Baines

Published by Oxford University Press, Oxford & New York, 1992

The Oxford University Press has come out recently with a fine encyclopedia of instruments called *The Oxford Companion to Musical Instruments*, written and edited by Anthony Baines. It is an affordable, easy-to-read, relatively concise work (404 pages), loaded with details about history, construction, appearance, playing styles, etc. about hundreds of instruments around the world. From the West to the East, to the North and South, it leaves little out in exploring diverse types ranging from the aeolian harp and Indonesian chalung, to the Norwegian hardanger fiddle and Laotan khen, to the Medieval tromba marina and Chinese xia. When compared to two of the most popular musical instrument encyclopedias already out in the market, the much longer and more expensive *New Grove Dictinary of Musical Instruments* edited by Stanley Sadie, and the lighter *Musical Instruments of he World* by the Diagram Group, the *Oxford Companion* fares well, since it takes the best of both publications and combines them into one complete, informative book. Of course faults aren't obsolete, so to get a better picture of what the *Oxford Companion* has to offer, a comparison/contrast of randomly selected instruments from the *Oxford* and its closely related rival, the *Grove Dictionary*, seems in order.

My first pick was the ancient Greek double reedpipe instrument, the aulos. The *Oxford* has a decent six paragraph description of the instrument along with its history, and comparisons to related instruments, such as the Egyptian monaulos and Roman plagiaulos. The *Grove* takes a more detailed approach in elaborating on the usage of specific names of the parts of the instrument and extensive investigation into history as well as current debates about whether the aulos was a single or double reed instrument and the possibilities of it being used for polyphonic or monophonic music.

The Finnish kantele was the next choice. *Oxford* dealt with the instrument in a concise and to-the-point manner, breaking the discussion into traditional and contemporary categories, and focusing on its history, construction, and musical repertoire. Again *Grove* went to great technical lengths in the presentation of instrument sizes, tuning schemes, obscure origins, and the evolution from the kantele's traditional, simple, melodic playing style to the more complex, harmonic interval playing style of today.

My third choice was the bowed Renaissance and Baroque instrument, the viol. Both books held detailed descriptions of the instrument itself, information abut tunings, playing, English and French music, as well as good historical discussions of the instrument's medieval origins in the waisted fiddle of the Middle Ages and the vihuela de arco.

With these comparisons, along with further delvings into the book, one finds that Anthony Baines' forte is the western classical instruments such as woodwinds, brass instruments, guitar/lutes, keyboards, and harps. This doesn't mean he overlooks instruments from other parts of the world, because he certainly mentions in detail many world instruments, familiar and obscure, as well as dedicating entire sections to each country of the world. It simply means that those categories aren't quite as lengthy and meaty as the western classical ones are. Baines also includes several entries on music-related phenomena, such as harmonics, beats, partials, etc., which are a delightful addition

to the instrumental contributions.

Ah, but one mustn't forget the pictures! In comparison to *Musical Instruments of the World* one will find Baines' book to be short on pictures. There are many, of course, but simply not enough of the lesser known instruments, which the *Grove* and *Musical Instruments of the World* seem to delight in exploring.

Ultimately though, one must consider the differences and evaluate them accordingly. For its relatively inexpensive price of £25, *The Oxford Companion to Musical Instruments* offers a substantial body of knowledge not to be sneezed at. Jeremy Montagu of FoMRHI (Fellowship of Makers and Restorers of Historical Instruments) describes it as "a tour de force, the work of a master. However much you know about instruments, about any instrument, you will learn more here." For one who cannot afford the in-depth, sometimes technical extravaganza of *The New Grove Dictionary of Musical Instruments* (at a cost of over three hundred dollars), and who doesn't get enough from the attractive graphics of *Musical Instruments of the World*, then Anthony Baines' book, *The Oxford Companion to Musical Instruments* is the best route to take.

NOTICES

SOUND STORIES #1, a video by Phil Dadson. 60-minute video featuring 14 leading American experimental musical instrument builders – a unique presentation of a unique subject. Available from Sound Stories, PO Box 66060, Beachhaven, Auckland, New Zealand. VHS: $60 NZ; SVHS: $75 NZ, postage included, payable by bank cheque only. [9-1]

FREENOTES – Beautiful Music Made Simple. Freenotes are bar-percussion instruments that make playing music easy for anyone. Designed during a two-year residency with the Paul Winter Consort, Freenotes are useful ensemble additions as well as first instruments for beginners. Priced from $165.00. For info call or write: Richard Cooke, P.O. Box 1492, Moab, UT 84532, (801)259-4411.

A HOUSE OF INSTRUMENTS is a limited edition collection of 23 drawings by Robin Goodfellow, including many that have appeared in EMI over the years. 8 1/2" x 5 1/2" booklet now, available for $5 (that includes postage & handling) from Mandala Fluteworks, 1655 Vista, Oakland, CA 94602.

Newly released: **The Just Intonation Primer** by David B. Doty, a complete introductory text on the theory and practice of Just Intonation. Cost $7.50 plus postage & handling, or free with new membership to the Just Intonation Network. For information: The Just Intonation Network, 535 Stevenson St., San Francisco, CA 94013, Phone: (415)864-8123 FAX: (415)864-8726. [9-1]

Sale! SCRATCH MY BACK; A PICTORIAL HISTORY OF THE MUSICAL SAW AND HOW TO PLAY IT, by Jim "Supersaw" Leonard. Prepaid U.S. $15 per book, includes mailing ($22.95) value. KALEIDOSCOPE PRESS, Janet E. Graebner, 28400 Pinto Drive, Conifer, CO. 80433-5309. [9-1]

"LARK IN THE MORNING" is currently looking for collections and individual musical instruments to purchase. If you have anything for sale or are aware of anything for sale please contact us. We are interested in strings, woodwinds, brass, percussion, drums, ethnic instruments, bagpipes, traditional and folk instruments. Antique items, used items, instruments needing repair; you name it. We also have a stock of all types of instruments for sale. P.O. Box 1176 Mendocino, CA. 95460; (707)964-5569. [9-1]

PLUCK is a newsletter devoted to the Jew's harp. Subscriptions are $10/year (3 issues) and help support the annual Sumpter Valley Jew's Harp Festival. Free sample available: POB 14466, Seattle, WA 98144. Please make checks payable to Gordon Frazier.

What do you get if you cross Lee Iacocca (sp?) with a vampire? DOS answer: Autoexec.bat. Answer for the rest of us: Batmobile.

SING OUT, the folk song magazine, was founded more than forty years ago by Pete Seeger, and it's still growing. Starting with the summer 1993 issue Sing Out has gone to a larger 8" x 10" format. Sing Out is at 125 E. 3rd St., PO Box 5253, Bethlehem PA 1805-0253.

Furnitures, a bi-monthly journal, seeks submissions of scores, short essays, etc. in the following areas: indigenous musics of North America, soundscapes and ecology, sound poetry, text-music theory. Include SASE for return. We also review recordings. Send to: Mark Nowak, 227 Montrose Place, Apt. C. St. Paul, MN 55104.

Just Intonation Calculator, by Robert Rich and Carter Scholtz. A composer's tool for just intonation. Internal sound for tuning reference; microtonal ear training; shows modulations; reduces fractions; converts between ratios, cents and Yamaha tuning units; MIDI tuning dumps for many brands of synths, and supports MIDI tuning dump standard; includes dozens of tunings. Requires MacIntosh and Hypercard. Only $10.00. Soundscape Productions, Box 8891, Stanford, CA 94309.

MICROTONE GUIDE. 34 page booklet of microtunings for synthesizers or new instruments. Ethnic, historic, just, and equal tunings. Good sourcebook for beginning microtonalists. $7.50 to C. Fortuna, 1305 Hartrick, Royal Oak, MI. 48067

IBM CLONE FREEWARE for JUST INTONATION. Freestanding program calculates just modulations/demodulations/intertones/complements, as well as string positions and ratio to cents. Menu driven, includes source code. Send formatted disk 51/4 or 3.5 inch, one dollar return postage (suggested) or trade material. NOVOSONICS, RFD 1 Box 312, Contoocook, NH 03329.

QUARTZ CRYSTAL "SINGING" BOWLS", frosted and clear in 12 sizes, in all musical notes available – magical – powerful healing tools for meditation and stress elimination, balancing energies, etc. Also available: handheld square drums, hoop and dance drums as well as water and ceramic kettle drums, various types of RAINSTICKS, melodious chimes, bells, cymbales. Largest distributor, lowest prices. The CRYSTAL STORE 1-800-833-2328.

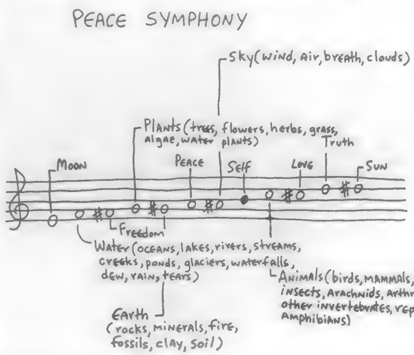
A REMINDER – Unclassified ads here in EMI's notices column are free to subscribers for up to 40 words; 40¢ per word thereafter. For others they are 40¢ per word, 15 word minimum, with a 20% discount on orders of four or more insertions of the same ad.

MICROTONAL MIDI TERMINAL (vers. 1.2) by Denny Genovese lets you play nearly any MIDI synthesizer in Just Intonation! A veritable "tuning processor" as well, it has many features for constructing, editing, transposing, analyzing and printing Just Scales. Tuning data is shown in Ratios, Cents, Frequencies and Yamaha TU's. Those without a MIDI instrument can hear the Just scales on the computer's built in speaker. Holds 16 scales in memory, which are selected by single keystrokes. Tunings may be transposed into any key with another quick stroke. Requires IBM XT/AT or compatible and, for performance, an MPU-401 or compatible MIDI interface. $60 from DENNYS SOUND & LIGHT, PO Box 15464, Gainesville, FL 32604.

SUBSCRIPTIONS TO EMI: $24/yr for U.S.; $27/yr for Canada & Mexico; $34/yr overseas. California residents add 7.25% sales tax for a total of $25.74. Order from EMI, Box 784, Nicasio, CA 94946, USA.

EMI BACK ISSUES: Bound volume sets Vol I through Vol V: $17 per volume. Single issues Vol VI #1 through Vol VII #6: still $3.50 per issue. Single issues Vol VII #1 and later: $6.00 per issue. These prices include postage for U.S., Canada & Mexico air, and overseas surface rate. In California add 7.25% sales tax. For overseas air add 20%. Order from EMI, PO Box 784, Nicasio, CA 94946, or write for complete listing of back issues and their contents.

CASSETTE TAPES FROM EMI: $8 per cassette for subscribers; $10.50 for non-subscribers. Prices include postage for U.S., Canada, Mexico air, and overseas surface rate. In California add 7.25% sales tax. For overseas air add $20%. Each tape contains music of instruments that appeared in the newsletter during the corresponding volume year, comprising a full measure of odd, provocative, funny and beautiful music. Volumes II, III, VI, VII and the recently-released VIII remain available; volumes I, IV and V are now sold out. Order from EMI, Box 784, Nicasio, CA 94946.



ECOSCORE by Steve Heitzeg (one of a series).

SPHERICAL EPOXY RESONATORS

by Drew Pear

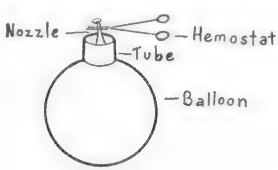
I enjoy crafting glass marimbas. Being inspired by the traditional gourd resonated African xylophones, I envision a glass marimba with spherical glass resonators. However, not having ready access to blown glass for the resonators, I worked out a method of constructing glass-like spherical resonators using balloons and 5-minute epoxy. The method is relatively inexpensive, quick and effective. The basic approach is to apply a design to a balloon inflated to the proper size and then coating the balloon with the epoxy except for a circular patch which will serve as the sound hole. When the epoxy has set, the air is let out of the balloon which is then easily removed from within the epoxy shell through the sound hole. The design applied to the balloon adheres to the inside of the epoxy shell due to the fact that the epoxy exerts a greater adhesive ability than the balloon does to the applied design medium. By making use of a variety of design mediums such as acrylic, enamel, and latex paints, markers in all their variety and applique materials such as glitters, foils, threads, frits, wax, etc. a wide range of visual effects are possible and allows one to tailor the design on the resonators to match or compliment the type and color of glass used in the marimba design.

Materials that I have found useful in the construction of the resonators are as follows:

- Large tubes of 5-minute epoxy (1.75oz)
- Small round balloons
- Poster board
- Small paper cups
- Disposable paint brushes
- Masking tape
- Calculator capable of finding cube roots ($\sqrt[3]{\ }$)
- Metric ruler
- Hemostats
- Calipers

The application of the epoxy to the balloon is a process that moves along very quickly. Therefore, it's important to set up the process so as to work quickly and efficiently. A method of holding onto the balloon while applying the design and the epoxy is needed. Another consideration is that a sound hole of the proper size must be left during application of the epoxy. These concerns can be met in the following manner. From the poster board cut a strip 30mm wide and long enough so as to construct an open-ended tube with an outside diameter 2mm smaller than the diameter of the sound hole. Secure with tape. Upon inflating the balloon the nozzle part is put through the tube and clamped with the hemostat as shown below.

The hemostat will rest against the tube due to the pull of the elastic balloon. The balloon should be inflated slightly larger than needed and then the air slowly let out in short stages until the proper diameter is achieved upon measurement with the calipers. This set-up can then be held by the hemostat for easy application of the design and epoxy. The tube serves as a guide for the sound hole diameter. For example, if the diameter of the sound hole will be 35mm (which has been a good working diameter for me), by making the exterior diameter of the tube 33mm and applying the epoxy to within 2mm of the tube, the effective sound hole size will be 35mm and of a symmetrically round nature which is ideal. For an interesting color swirl effect evident in certain styles of stained glass, the balloon can be dipped in various colors of paint before inflating and when inflated, the paint swirls quite nicely over the surface of the balloon. A little extra care is needed when applying the tube and hemostat, and when measuring the diameter of the balloon with the calipers.



To apply the epoxy, secure a paper cup in a holder of some sort so you won't have to hold on to it when mixing and applying the epoxy. Epoxy comes in two parts, the resin and the hardener. Place each part in the cup separately. When putting the second part in the cup, do it quickly and mix them together quickly using a small wooden stick such as a popsicle stick. Time is of the essence now. Using the brush apply the epoxy quickly over the entire surface of the balloon. First, spread some epoxy closely around the perimeter of the tube to within four millimeters. You will lay in a second, more accurate, application of epoxy around the tube later so the first application need not be perfectly symmetrical. Then cover the rest of the balloon quickly by laying the epoxy on in thick globs and spreading it around. Until the epoxy sets you will notice that it will tend to slide around and pile up on the balloon and would drip off if you don't take steps to prevent it. To do this you must constantly rotate the balloon side to side, up and down and all around allowing gravity and the surface tension of the epoxy to even out the coating. By staying visually aware of the movement of the epoxy and rotating the balloon accordingly, the coating will be relatively even when it sets which will happen pretty quick. When the epoxy has set, carefully lay in a thick bead of epoxy around the perimeter of the tube at the proper distance. When this second bead sets, secure the handle of the hemostat by allowing the resonator to hang over the edge of a table and applying a weight to the handle of the hemostat resting on the table. Let epoxy cure for 1 hour.

The next step is to remove the balloon. Gently hold the resonator and remove the hemostat and the tube. Gently push the balloon away from the inside of the epoxy shell using the eraser end of a pencil and remove. You should now have a functioning resonator.

To determine the proper diameter of the resonator depending on the frequency of the note you wish to resonate, use the following formula:

$$D = 386\,(\sqrt[3]{d/f^2})$$

where

D = diameter of resonator in centimeters
d = diameter of sound hole in centimeters
f^2 = frequency of note to be resonated, squared (fxf)
$\sqrt[3]{d/f^2}$ = the cube root of d divided by f^2

With this method of manufacture, the resonator is generally supported from below with the marimba keys supported over

the resonator. An alternate method consists of having a neck extending from the soundhole which allows the resonator to be attached by the tube through holes in a platform which also supports the keys similar to a standard western xylophone/marimba. In this instance the tube used in the manufacture of the resonator is best made from plastic or wood with an internal diameter equal to the diameter of the sound hole. The sides of this tube are covered with epoxy after coating the balloon and a heavy bead of epoxy is applied at the resonator/tube juncture. A separate formula is needed for this style.

$$D = 356\sqrt[3]{(d/f)^2 \div (L + 0.7d)}$$

where

D = diameter of resonator in centimeters
d = diameter of sound hole in centimeters
f = frequency of note to be resonated
L = length of tube or neck in centimeters

Drew Pear can be reached care of Jana Cuzzort, 3741 Plaza Dr., Ann Arbor, MI 48101.

Editor's Report

AND ON AND ON AND ON

Our last issue marked the start of *Experimental Musical Instruments'* ninth year of publication. In earlier years I have always taken the opportunity of the anniversary to report to the readership on how the journal is getting on. I didn't make my report in the last issue though, for reasons having to do with space allotments in a very crowded issue. Here is my report now, one issue late.

Experimental Musical Instruments continues to follow much the same path it has since its inception. The journal's guiding purpose remains, now as always, to report on the great diversity of possible musical sound-making instruments, with an emphasis on the unusual, the ingenious and the inventive.

EMI's reviews sections have broadened a bit for recent issues, as we have brought in a number of new reviewers for both books and recordings. In coming issues we will be including the occasional video review, software review, and organization or periodical review as well. Broadening the reviews sections allows us open up a window on a wider range of topics that would otherwise be near the periphery of EMI's subject matter, while still adhering to EMI's primary purposes in the feature articles.

In recent issues we have included a bit more material on electronics than in the past, and some of the recent articles may have seemed more technical than the standard fare. If you are one of the readers for whom electronics or technical data are not a primary interest, have no fear. Plenty of our readers do have strong interests in such things, but it's important that the other part of EMI's world -- the acoustic instruments, and the topics that don't require a technical background to comprehend -- remain central. At the heart of EMI's purpose is something about what it feels like to make an instrument and then play it. I'll be working to ensure that that sense does not get lost in the mix.

And now some speculative thoughts about future directions. It sometimes strikes me, as I think about EMI and its position and purpose in the world, that there's an important subject area that isn't part of EMI's portfolio, and yet which perhaps *should* have a journal somewhere to serve as its forum. I am thinking of the broader subject area of practical musical instruments and instrument making -- homebuildable instrument making -- without EMI's current emphasis on unconventional or non-standard types. In other words, it seems to me that there ought to be an EMI-like magazine for people with less interest in exotics – a journal of hands-on appreciation for musical instruments of all sorts, from American and European folk instruments, to instruments evolving in Asia and Africa and the Pacific, to historical instruments from all parts of the world, to current inventions and explorations.

Would EMI do well to try to be such a journal?

Well, in fact, EMI has in recent years moved in that direction, at least to some extent. This means only that we have made an effort to include more articles looking to the how-to and pure enjoyment of instruments that are interesting, but are perhaps not so new or exotic. And we have included a lot of practical information on design and construction which applies equally well to conventional and to new instrument types. Reader response to these articles has been good, and I intend to keep them coming. This progression toward a more balanced output seems like a natural and healthy evolution for EMI. Yet the word "experimental" in our title, and our history of well-advertised fascination with highly unconventional types, make it unlikely that EMI, in its present form, would ever really become the broader-based journal envisioned a paragraph or two ago. If nothing else, the title and that history throw up a barrier for potential readers who are primarily interested more conventional instruments.

So where does all this speculation lead? Probably to nothing more radical than this: EMI will continue to open itself up to a broader range of instrument types, including some things things that aren't so very "experimental," as long as our subscribers seem happy with this. A more extreme response would be to create a born-again EMI, with a new title and a slightly different mandate. Or, I or someone else could consider creating a sibling journal to exist alongside EMI. Neither of these seem likely at the moment. But if any of you, readers, have thoughts on this, let me know.

Meanwhile, allow me to remind everyone of all the things I remind everyone of each year at this time: EMI thrives on contributions and comments from its community. Letters to the editor are always welcome, and are a good way to communicate with the readership as a whole. If you do write, you can help the editor by indicating whether your letter is intended for publication or not, or which portions are for publication. We also welcome suggestions for article topics, publications or recordings for review, and the like. Remember that subscribers can place ads or other blurbs in the notices column of up to 40 words free of charge (write for complete advertising information). And we are always interested in article submissions. Many of our best pieces come from readers who see in EMI an opportunity to share knowledge or ideas that they possess. Call or write for an information sheet on writing for EMI, and be sure to check in, by phone or letter, before undertaking a substantial writing project with EMI in mind.

Finally, a word of appreciation. At this little office in Nicasio, I pull together the work of a great number of people. Some write, some do research, some take photographs or do graphics work, some do all these things and lots of other things. All have a great deal to offer and all have been hugely generous. These people know who they are, and hopefully the readers as a whole know who they are, from seeing the various credit lines.

To all: *THANKS.*

Here is another installment in **Experimental Musical Instruments'** *sporadic reprints series, featuring articles about unusual or home-buildable instruments gleaned from early periodicals. This time, rather than a single longer article, we have two short ones. Our thanks go to Don Dries, who brought them to EMI's attention.*

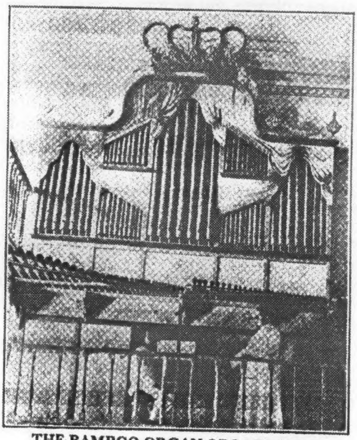
"A Bamboo Organ" originally appeared in the November, 1926 issue of **The Etude**. **The Etude**, now defunct, was published from 1883 to 1957 by Theodore Presser Company. No author or photo credit appeared with this article.

A BAMBOO ORGAN

The accompanying picture of a bamboo organ in the Philippine Islands at Las Pinrs, Rizal, was sent to *The Etude* through the kindness of Sister Marie Claudia of Belgium who, for years has been a very good friend of *The Etude*.

The picture was sent to her by another sister in the Philippines who describes the organ thus:

Here is something which will interest you, an organ whose big pipes are in bamboo. It was made more than a century ago, by a Spanish Franciscan Monk, and the natives of a village near Manila. The most ancient (the oldest) have transmitted the secret of the preparation of the bamboo to render it sonorous to the following generation, but they keep it carefully. It is said that one of the conditions is to bury the trunks of the bamboo during several years in the sand. The Father in white is a Belgian missionary, who has, for a long time, been Curate of this village and has had the organ repaired. He is actually our Chaplain and it is to this Church that we go to Mass when we pass a few days' vacation at the seaside at San Jose de las Pinrs.



THE BAMBOO ORGAN OF LAS PINRS

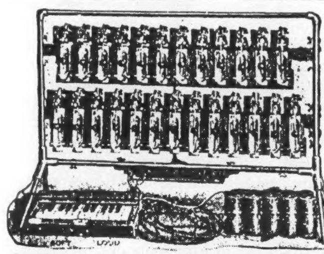
The Electrical Experimenter first published this "Electric Una-fon" article in July, 1917. **Electrical Experimenter** magazine was published by Experimenter Publishing Company from between 1913 and 1920. No author was credited for the following article. EMI has diligently preserved several errors appearing in the original, including the fractured third paragraph. The instrument described was designed and manufactured by the Deagan company; a few specimens survive today.

ELECTRIC UNA-FON MAKES MUSIC TO BEAT THE BAND

The electric Una-Fon here illustrated is played from a keyboard, the keys of which are exactly the same as those of a piano. No previous experience is necessary for its successful use and any piano selection can be played on it, both harmony and melody. The instrument is said to mark a new departure in tone quality, it having been likened by some to the *Vox Humana* of a pipe organ. The Una-Fon may be played either soft or loud and is equally adapted to use in theater or in the open. In street work, under fair conditions, it may be heard several blocks; it has wonderful volume and carrying capacity. On the water its clear, brilliant tone carries great distances. The maintenance expenses is kept at a low figure by reason of the storage battery supplied with each set, cutting the operating cost down to two or three cents an hour.

Each tone-producing unit is a patented special alloy, nickel plated concave steel bar, mounted over a special resonator on a solid oak frame, with an electric playing action attachment. It remains in perfect adjustment, produces a fast vibrating stroke and wields a large composition mallet that brings out the full beauties of the tone. The instrument is not affected by atmospheric conditions, and retains its tone at all times. The various electric actions are firmly mounted on solid oak cross-pieces on nickel plated floor rack that occupies minimum space and can be moved anywhere. The keyboard is connected thru a ten-foot flexible cable.
electric musical instruments such as the Xylophone, Marimbaphone, etc., as these can be played from the same keyboard.

The third unit of this instrument comprises a small, light battery case for holding dry cells of standard size, which is constructed with fastenings so that it may be attached to any part of the machine that is found convenient. The three parts of the apparatus are connected by a single cable, of such length that the whole apparatus can be instantly attached to any of the standard instruments now in use.



A Novel Electric Musical Instrument Which Is Played from a Keyboard Exactly Like That of the Piano.

A 34-EQUAL GUITAR

by Larry A. Hanson

I recently had a 34-tones per octave electric guitar constructed which has been and will continue to be evaluated by guitarists interested in microtonal music in the Los Angeles and New York areas.

The standard 12-tone per octave fretted neck of a standard Fender® Telecaster® was removed; and a new neck, fretted for 34-equally tempered tones per octave, was attached. This work was done by Carruthers' Guitars in the Los Angeles area.

When I am asked "Why 34?" I drag out my copy of Scott Wilkinson's *Tuning In* [Milwaukee: Hal Leonard Books, 1988] and turn to page 81. When one examines Wendy Carlos' diagram closely and reads the text, it is apparent that 34-equal is the best approximation to "Classical Just" of any system of equal temperament short of 53-equal. And 53 is just too many frets for a guitar.

Although having received passing mentioned for centuries, no-one (to my knowledge) has previously advocated or promoted the use of any instrument employing the 34-equal tuning.

Two features particularly characterize Western music. One is the use of the harmonic resources of the intervals of major and minor thirds. The other, which occurs in works of any length, is the harmonic variety provided by modulation to different keys. In accommodating both these objectives, 34-equal shines. A most important musical feature of 34-ET is that it distinguishes the small pitch difference between the major and minor whole tones known as a comma. Use of the "commatic inflection" characterizes much near-East and Indian music. In the West, historically, the comma was considered a nuisance and tempered out of existence – initially by various mean-tone scales and finally by 12-tone equal temperament.

The most practical tuning of the strings of this guitar seems to be that of the conventional guitar: E,A,D,G,B,E; although other tunings are possible.

Since almost two thirds of the 34-equal fretboard is occupied by frets for tones which are not fretted on the conventional guitar, there is comparatively little latitude for finger placement.

I have devised a system of naming these tones, and ways to notate them on a musical staff. For example the 5 tones between F and G, and their notation are:

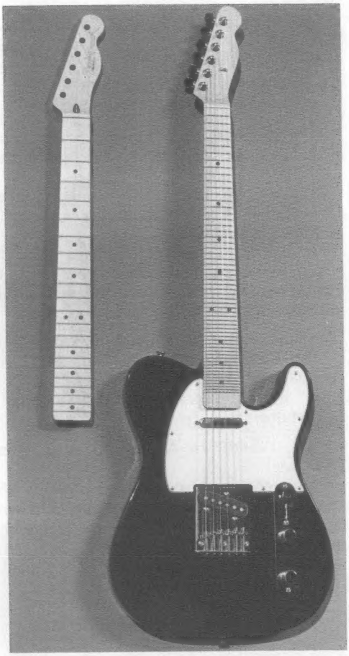
F:14 /F:15 F#:16 /F#:17 G*b*:18 \G:19 G:20

"#" means the pitch is raised by two (2) scale steps from the natural tone; "*b*", pitch lowered by two (2) scale steps from the natural tone; "/", pitch raised by one (1) scale step from the nominal tone; "\", pitch lowered by one (1) scale step from the nominal tone.

I have given this 34-equal system of tones and notation the name SELENE system, since the 34th chemical element in the atomic series, Selenium, is also named for this moon goddess.

Some have asked if a keyboard for the SELENE, 34-equal, system exists. The answer is that the design for a keyboard does, but it has not been actually constructed. The layout was described in my article "Development of a 53 Tone Keyboard Layout" in *Xenharmonikon XII*, 1989 (available from Frog Peak Music, Box 5036, Hanover, NH 03755).

I am writing a longer, more technical, description of the SELENE system for publication. In the meantime I will attempt to answer, by phone or mail, questions addressed to me at: 3900 Deervale Dr., Sherman Oaks, CA 91403.



At right: Guitar fretted for 34-tone equal temperament (shown with a 12-tone equal temperament fretboard alongside for comparison:)

Photo by Bev Soroka

RECENT ARTICLES, continued from back cover

In addition to these, there are articles on bassoon refinishing, wind instrument repair schools, intonation in antique flutes, an improved type of flute pad, tips for making good cork-lined joints in wind instruments, and more.

"A New Look at Harp Guitars," by Jonathan Peterson, in **American Lutherie** #34, Fall 1993 (8222 South Park Ave, Tacoma WA 98408).

This article follows the same author's previous piece on early harp guitars with an inspiring look at contemporary instruments by several makers.

Also in **American Lutherie** #34 (address above): articles on guitar top replacement and fretboard shaping, profiles of or tributes to several guitar makers, and more.

And in **American Lutherie** #35, Summer 1993 (address above):

"It's a Kabosy" by Paul Hostetter describes this guitar-like instrument, with its unique fretting arrangement and varied shapes, from Madagascar.

"Some Alternative Lutherie Woods" by Tom Ribbecke is a transcription of an informal lecture given at a 1992 luthiers' convention; it is followed by "Alternative Lutherie Woods List" by Nicholas Von Robison, which lists 28 woods and describes their properties.

– plus, this issue contains articles on violin setups and historical lute construction, profiles of or tributes to several makers, and more.

The following is a listing of selected articles relating to musical instruments which have appeared recently in other publications.

"Braiding Hot Rolled Steel" by Daniel Goode, in **Musicworks** 56, Fall 1993 (179 Richmond Street West, Toronto, Canada M5V 1V3 [new address]).

A look at the work of Barbara Benary, director of the American gamelan Son of Lion in New York City. The article focuses on many facets of Benary's work, touching briefly on her instrument making work for Son of Lion.

"A Sound Slap: Futurism and the Art of Noises" (no author credited), in **Sonic Striations** issue #1 (193 S. Railroad St., Hummelstown PA 17036-2114).

A historical discussion of the noise music of Russolo and fellow futurists.

"Parting Glance" by Andrew Essex, in **Piano & Keyboard**, Sept./Oct 1993.

A photo accompanied by brief notes, showing Rebecca Horn's museum installation "Concert for Anarchy." The installation consists of a grand piano suspended from the ceiling of the Gugenheim Museum. The piano intermittently produces a loud tone cluster as its keys suddenly explode outward, then silently retract again.

"Ladder or cloud?" by Ben Hume, in **Pluck**, Spring/Summer 1993 (PO Box 14466, Seattle, WA 98114).

A distinguishing feature for different Jaw harps the world over is whether the vibrating tongue produces a well-defined harmonic overtone series or a more ambiguous set of non-harmonic partials. This article discusses the determining factors and the pros and cons of these characteristics.

"The 'Proportional Chromatic' Piano Keyboard & Music Notation" by Henri Carcelle, in **Music Notation News** *Vol 3 #2, 2nd Quarter 1993 (PO Box 241, Kirksville, MO 63501).*

A report on a modified keyboard layout and notation system for chromatic music.

Three magazines have just recently come out with articles on the group Tarika Sammy from Madagascar. Members of the group play traditional Malagasy instruments along with contemporary re-makes of traditional instruments. Most of the instruments are made by group members; a few have been made to the group's specifications by western luthiers. The magazines with the articles are **Sing Out** Vol. 38 #2, Aug-Oct 1993 (125 E. Third St., Bethlehem, PA); **High Performance** #62, Summer 1993 (1641 18th St., Santa Monica, CA 90404); and **Option** #52, Sept/Oct 1993 (1522-B Cloverfield Blvd., Santa Monica, CA 90404).

"Godfried-Willem Raes – 'Virtual Jewsharp Project'" in **Logos-Blad** Vol 15 #8 (Kongostraat 35, 9000 Gent, Belgium).

Godfried-Willem Raes describes an installation in which participants' movements are translated into sound by means of electromagnetic radar technology.

"Kiekjes Uit Krems: een Oostenrijks beelverhaal door Moniek Darge", also in **Logos-Blad** Vol. 15 #8 (address above).

A set of photographs (coarsely digitized) of sound installations by Matt Heckert, Godfried-Willem Raes, Horst Rickels, Paul Panhuysen and others, with brief captions in Dutch.

"Tricone Resonator Guitars Available Again After 50 Years," in the *Product News* section of **Music Trades**, August 1993 (80 West St., PO Box 432, Englewood, NJ 07631).

Saga Musical Instruments is producing a beautiful steel-body "resophonic" guitar (examples of resophonic guitars are Dobro and National Steel), reproducing a 3-cone resonator design long out of production.

The Winter 1992 issue of **Computer Music Journal** (Vol. 16, #4; Cambridge, MA) featured articles on computer modeling for acoustic instruments. "Physical Modeling of Wind Instruments," by Douglas H. Keefe, discusses attempts to develop mathematical models that accurately reflect and predict the behavior of wind instruments. "Physical Modeling of Bowed Strings," by James Woodhouse, does the same for strings.

"Le Tambour du Burundi" in **Percussions** #29, July/August 1993 (18, rue Theodore-Rousseau, F-77930 Chailly-en-Biere, France)

A report on drums of Burundi. In French.

"A Dulcimer in a Box: Check It Out!" by Ralph Lee Smith in his *Mt. Dulcimer Tales & Traditions* column in **Dulcimer Players News** Vol. 19 #3, July-Sept 1993 (PO Box 2164, Winchester, VA 22604).

Photographs and notes on some rare dulcimers built into cases with lids.

Also in the July-Sept issue of **Dulcimer Players News**: A report on tonewoods for use in dulcimer making, in Sam Rizzetta's *Technical Dulcimer* column; and profiles of two dulcimer makers.

Koukin Journal No. 5, December 1992 (1-12-24, Midorigaoka, Ageo, Saitama 362, Japan) contains 13 articles in Japanese on jaw harps and surrounding lore from the world over, with topics ranging from traditional jaw harps of Russia, Japan, Nepal and elsewhere, to depictions of the instruments in the paintings of Pieter Bruegel.

FoMRHI Quarterly No. 72, July 1993 (c/o Faculty of Music, St. Aldate's, Oxford OX1 1DB, U.K.) contains an array of short articles and communications on issues relating to early instruments and their construction, including pieces on medieval glues, a baroque oboe, a relatively affordable CAD/CAM lathe, and more.

Issue 2 of **The Woodwind Quarterly** (August 1993) contains a wealth of articles on woodwind topics:

"The New Fingering System and Flute Design," by Jim Schmidt, describes a redesigned chromatic silver flute (also described in EMI Vol. III #5).

"The Renaissance of the Native American Flute," by Ken Light, talks about the flute of some of the peoples of the northern plains, with its several distinctive features, that has continued to evolve and become an important contemporary instrument.

"Acrylic Wood Stabilization," by Scott Hirsch, talks about a potentially important development in wood preservation technology, and applies it to the making of a flute.

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